

FINAL ENVIRONMENTAL IMPACT STATEMENT

on a

Proposed Nuclear Weapons Nonproliferation
Policy Concerning Foreign Research Reactor
Spent Nuclear Fuel

Appendix D Selection and Evaluation of Potential Ports of Entry



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Appendix D

Selection and Evaluation of Potential Ports of Entry

This appendix describes the process used by the Department of Energy (DOE) in selecting the potential ports of entry analyzed in this Environmental Impact Statement (EIS). In addition, the appendix provides the basic information required to evaluate ports and port activities, and the potential environmental impacts (incident free and accidents) associated with the receipt and handling of foreign research reactor spent

nuclear fuel from vessels to intermodal transport in ports.

D.1 Ports of Entry Selection Process

The adopted port selection process was based on a set of criteria developed by DOE to identify those ports that would be most capable of providing for the safe receipt, handling, and transshipment of foreign research reactor spent nuclear fuel. This appendix first describes the process through which DOE developed the port selection criteria, and then describes the application of the criteria, resulting in the identification of the specific ports available for consideration.

Because the basic implementation of Management Alternative 1 of the proposed action would involve shipments from many foreign countries to several potential foreign research reactor spent nuclear fuel management sites in addition to those identified in the Environmental Assessment of Urgent-Relief Acceptance of Foreign Research Reactor Spent Nuclear Fuel (DOE, 1994d), it was necessary to expand on the port analysis approach used in the Urgent Relief Environmental Assessment. The Urgent Relief Environmental Assessment was concerned with fewer shipments within a short timeframe, with the shipments going only to the Savannah River Site. Also, as stated in the Urgent Relief Environmental

D.1.2 Information on Past Spent Nuclear Fuel Shipments

The NRC has the authority under the Atomic Energy Act of 1954, as amended, to regulate certain aspects of spent nuclear fuel transportation. Of the thousands of shipments completed over the last 30 years in the United States and abroad, none has resulted in an injury due to the radioactive nature of the cargo (NRC, 1993). For the same period, about 1,200 (924 domestic and 293 foreign) overland shipments of spent nuclear fuel took place without any injury attributable to accidents or incident-free radiation doses during transport. Table D-1 provides the number of NRC and Department of Transportation regulated international and domestic overland shipments since 1979 (excluding DOE shipments). The casks that would be used in this program are robust Type B containers. The safety, safeguards, and precautions used for such shipments have historically been very successful (NRC, 1993).

Table D-1 Number of NRC/Department of Transportation Regulated Overland and International Spent Nuclear Fuel Shipments

Year	Overland		International ^a	
	Highway	Seaport	Domestic	Foreign

(b) availability of safe and secure lag storage; (c) adequacy of overland transportation systems from ports to the storage site(s); (d) experience in safe and secure handling of hazardous cargo; (e) emergency preparedness status at the port and nearby communities; and (f) proximity to the proposed storage sites." Either implicitly or explicitly, these criteria were considered in the port screening, as discussed in the following sections.

D.1.5 The U.S. Merchant Marine Academy Workshop Recommendations

A DOE-sponsored workshop on port selection criteria for spent nuclear fuel was held at the U.S. Merchant Marine Academy at Kings Point, New York, on November 15-16, 1993 (USMMA, 1994). Participants at the workshop included experts from the maritime industry in the areas of marine transportation, intermodal systems, marine insurance, admiralty law, U.S. Coast Guard Operations, U.S. Navy Operations, Military Sealift Command Operations, and national cargo, pilotage, and ships operations.

A series of panel discussions focused on issues such as economics and transportation safety, advantages of shipping spent nuclear fuel on various types of vessels, and shipping spent nuclear fuel through large versus small ports. The purpose of such discussions, in part, was to enable DOE to identify port criteria that would minimize both the actual and perceived risk involved in spent nuclear fuel shipments. The workshop participants agreed that any port capable of handling an ocean-going vessel is capable of receiving spent nuclear fuel. While some of these ports might have features that would make them more desirable than others (e.g., easy access from the open sea, modern facilities, etc.), no port would have such limitations as to preclude safe receipt of the spent nuclear fuel. While individual ports might not satisfy all the criteria recommended at the workshop, the workshop participants concluded that the criteria would provide a means of evaluating the relative merits of ports.

The three criteria recommended as necessary for safe shipment were: short distance from the open ocean to the port, adequate port cargo facilities, and intermodal access (i.e., for truck or rail shipments from the port to the management site).

A second set of recommendations that were listed as "important but not necessary" included: an experienced risk management staff, emergency preparedness and response capabilities, a skilled labor force aboard ship and in port, good port security, no local restrictions or regulations on movement of hazardous cargo, and no significant environmental considerations for the port.

Finally, the workshop also provided a list of "desirable" attributes for ports, including: distance of the port from a population center, proximity of the port to a spent nuclear fuel management location, "local economic issues" (e.g., areas that receive a significant fraction of their revenues from maritime and shipping activities), and personnel with training and experience in radioactive shipments and incident response.

D.1.6 Provisions of the National Defense Authorization Act for Fiscal Year 1994

On November 30, 1993, the National Defense Authorization Act for Fiscal Year 1994 was signed into law (NDAA, 1993). Section 3151 stipulates specific criteria that must be used "if economically feasible" and "to the maximum extent practicable" in selecting U.S. ports for both emergency and nonemergency receipt of foreign research reactor spent nuclear fuel at the Savannah River Site. Although the National Defense Authorization Act does not specifically address other potential DOE management sites, DOE assumed that the guidance provided for foreign research reactor spent nuclear fuel shipments to Savannah

River Site should be considered for the other four potential sites being considered in this EIS (Idaho National Engineering Laboratory, Hanford Site, Oak Ridge Reservation, and the Nevada Test Site), to the extent feasibility and practicability permitted.

Specifically, the National Defense Authorization Act requires that DOE may not receive foreign research reactor spent nuclear fuel if it "cannot be transferred in an expeditious manner from its port of entry in the United States to a storage facility that is located at a Department of Energy facility and is capable of receiving and storing the spent nuclear fuel." Further, it requires that the "Secretary of Energy shall, if economically feasible and to the maximum extent practicable, provide for the receipt of spent nuclear fuel....at a port of entry in the United States which...compared to each other port of entry....that is capable of receiving the spent nuclear fuel - (1) has the lowest human population in the area surrounding the port of entry; (2) is closest in proximity to the facility which will store the spent nuclear fuel; and (3) has the most appropriate facilities for, and experience in, receiving nuclear fuel (NDAA, 1993)."

D.1.7 Comments Received During the EIS Scoping Meetings and on the Urgent Relief Environmental Assessment

Nine public scoping meetings were held in November and December, 1993, at six cities being considered as potential ports for the receipt of spent nuclear fuel from foreign research reactors, and four cities near the potential spent nuclear fuel management sites discussed in this EIS. As a result of these meetings, DOE received several groups of similar comments, which have been incorporated into the development of the criteria (DOE, 1994a).

The largest number of comments (44) received on any general port-related issue dealt with avoiding ports in high population areas. Reasons ranged from concerns about accident consequences and possible terrorist attacks, to concerns about the ability to adequately respond to emergencies and possible evacuation of populations.

The second largest number of comments (32) suggested that alternative ports in low-population areas or ports operated by the military be seriously considered, and that ports that are closest to the storage sites and/or have the most direct transportation routes between the ports and management sites be considered.

Other comments that fall within the jurisdiction of DOE and within the scope of this EIS include: suggestions that selected ports should have experience handling spent nuclear fuel (9 comments); the safest marine terminals should be used at the port selected (3 comments); and that DOE should allow case-by-case designation of ports based on the most sensible options at the time each individual shipment occurs, considering the vessel, country of origin, time, cost, and overall experience of the ports (2 comments).

In addition to comments presented at the EIS Scoping Meetings, DOE has also considered individual comments and a list of suggestions from the Sierra Club on the draft Urgent Relief Environmental Assessment (DOE, 1994d).

D.1.8 Key Assumptions and Methodology for Port Identification

A number of possible maritime shipment modes are potentially available for shipping the foreign research reactor spent nuclear fuel over the next 10 or more years. The various transport modes generally determine which port facilities are adequate at each specific port [e.g., container cranes are required for container vessels, a pier for roll-on/roll-off vessels, and breakbulk cranes for breakbulk vessels]. While regularly scheduled cargo ships servicing commercial ports could be an important mode selected by

owners of the foreign research reactor spent nuclear fuel for their shipments, smaller unscheduled vessels would also be a common mode of transport for multiple cask shipments (e.g., the first shipment of foreign research reactor spent nuclear fuel under the Urgent Relief Environmental Assessment in September 1994). This means that there will be a somewhat greater number of potential ports of entry to consider than if only larger, regularly scheduled commercial container vessels were to be used (details on potential vessel types that might be used are provided in Appendix C).

In addition to the types of vessels that could be used, the way foreign research reactor spent nuclear fuel casks are “packaged” for shipment is also a determinant in the selection of potential ports. For the Urgent Relief Environmental Assessment shipments to Savannah River Site, the Terms and Conditions for Financial Settlement for Receipt and Disposition of Foreign Research Reactor Spent Fuels (DOE, 1994c) required that spent nuclear fuel casks be containerized in 20 ft International Standards Organization containers (nominally, 2.4 m x 2.4 m x 6.1 m, or 8 ft x 8 ft x 20 ft), also called 20-ft equivalent units. Therefore, it was assumed that spent nuclear fuel casks would only be shipped containerized. This eliminates consideration of receipt and handling of foreign research reactor spent nuclear fuel casks in a “palletized” mode. Thus, the EIS focuses primarily on reasonable options for ports qualified for the receipt, handling, and transshipment of containerized spent nuclear fuel on any viable vessel type.

Among the ports that routinely handle containerized freight, two groups of ports - those along the in-land Mississippi River (above New Orleans) and those around the Great Lakes - are not considered in this evaluation. Access to these ports requires a long inland transit from open ocean. The U.S. Merchant Marine Academy recommendations discouraged such transits.

Finally, since the National Defense Authorization Act did not establish numerical distance or transport time limits for spent nuclear fuel transport, DOE concluded that, consistent with current and past Federal practice for transport of spent nuclear fuel in the contiguous United States, all overland shipments should be managed such that the spent nuclear fuel is kept moving as expeditiously as possible from the time it is placed on the transportation vehicle at the port of entry until it reaches the DOE management site, to the maximum extent practicable. For example, truck shipments (which typically involve two drivers in a tractor with a sleeping area) are assumed to be basically nonstop in order to deliver the spent nuclear fuel promptly, stopping only for fuel and food. This has been, and is expected to remain, DOE practice for such shipments.

NRC recently reported that for the period 1970-1997, rail transport only accounted for 8.6 percent of the

total spent nuclear fuel shipments in the United States, but these shipments accounted for about 66 percent of the total quantity of spent nuclear fuel shipped (NRC, 1993). Rail travel (freight) typically takes much

In both cases, DOE concludes that by proper planning and compliance with current Department of Transportation and NRC shipment requirements (including use of pre-approved routes), each shipment of foreign research reactor spent nuclear fuel could be moved expeditiously from each port to each management site, and specific distance and time considerations do not serve to usefully discriminate against ports in the contiguous 48 States.

D.1.9 Methodology for Port Selection

The methodology for identifying acceptable ports of entry began with a list of 153 commercial ports throughout the contiguous United States. These ports included the 151 ports that were originally considered in the Urgent Relief Environmental Assessment (DOE, 1994d). The two additional commercial ports are Eddystone, PA, and Fernandina Beach, FL. Also, eight additional military ports in the contiguous United States suggested by the Military Traffic Management Command (MTMC, 1994a) were evaluated. The eight candidate military ports were those believed to routinely handle dry containerized cargoes (largely munitions), on breakbulk, container, and/or roll-on/roll-off vessels. Military ports are subject to extreme fluctuations in port activities as a function of national need. By using the criteria described below, ports that did not meet each DOE mandatory criterion in the sequence were eliminated. Those ports not eliminated at each step of the screening process were then evaluated in the same fashion against the remaining required criteria.

The required screening criteria DOE used to identify potential ports of entry were:

- The ports must have appropriate (routine) experience handling containerized cargo (Criterion 1);
- The ports must offer favorable transits from the open ocean to the selected terminals (Criterion 2);
- The ports must have appropriate facilities for safe receipt, handling, and transshipment of foreign research reactor spent nuclear fuel (Criterion 3);
- The ports must have ready access for intermodal transport (i.e., truck and rail facilities at or close to the selected terminal) (Criterion 4); and
- The human population of the ports and along transportation routes must be low to the extent economically feasible and maximum extent practicable (Criterion 5).

of breakbulk, combination breakbulk/container ships, or self-contained ships that are equivalent to unloading (or loading) a small container vessel every week or two] were selected for further detailed analysis under the remaining criteria.

Because containerized spent nuclear fuel requires no special port experience or facilities specific to the handling of radioactive material, ports were not eliminated from consideration because of lack of such experience or facilities.

This criterion excludes experience in handling bulk liquid cargoes (e.g., oil or petrochemicals) or other bulk cargoes (e.g., grain, coal, etc.) unloaded using special cargo equipment not of the type used for receipt and handling of containerized foreign research reactor spent nuclear fuel shipments. It also excludes ports used primarily by fishing fleets or cruise ship liners.

Ports meeting the appropriate experience requirement would be those where port terminal(s) and operators routinely load and/or unload all types of containerized dry cargoes requiring the same type of handling as containerized spent nuclear fuel (e.g., everything from television sets and machine parts to toxic materials, flammable or explosive cargoes, etc.), or are likely to acquire such experience during the time period analyzed in this EIS (i.e., large cargo or container port expansions or improvements are planned within the next several years). DOE found that the status of commercial port facilities is very dynamic and subject to rapid and unpredictable changes. For example, the Port of San Francisco, CA lost four of its five major container lines to the Port of Oakland, CA early in 1994, and the Port of Morehead City, NC, has gone from on the order of 10,000 containers per year a few years ago to essentially no container service at the present time (DOE, 1994d). Similarly, the Port of Richmond, CA (while it still has two container cranes available and acceptable facilities) no longer receives significant numbers of containers (AAPA, 1994), although that could change in the near future.

This criterion also effectively eliminated ports that have infrequent container/breakbulk ship calls, marginal equipment or facilities, and were less likely to have well-trained and experienced personnel than busier ports during the period analyzed in this EIS (adequacy of ports and facilities for receiving, handling, and transshipping such cargoes will be addressed in Section D.1.9.3).

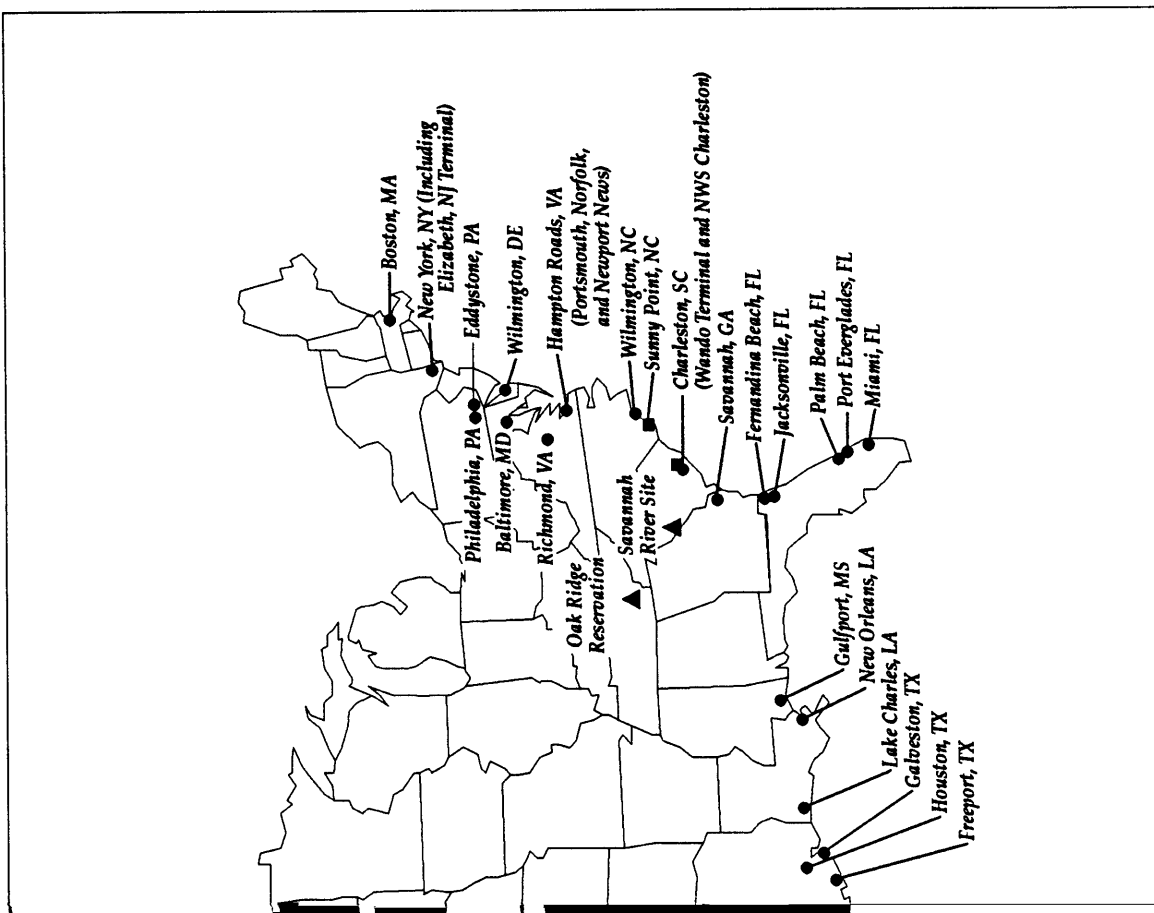
Out of the original list of 153 commercial candidate ports in the contiguous United States that were discussed earlier (excluding the 29 Great Lakes and upper Mississippi River ports), this screening resulted in the identification of 31 candidate seaports (see Table D-2 and Figure D-1). Many of the rejected ports were associated with oil or other bulk shipments, and were not viable for either breakbulk or container operations. These 31 commercial ports are considered to be reasonably representative of the total population of viable commercial seaports in the contiguous United States. Three of the eight military ports evaluated were found to generally satisfy this criterion, allowing for the cyclical nature of military activities at these ports (see Figures D-1 and D-2 and Table D-3). The acceptable military ports included the Military Ocean Terminal Bay Area in Oakland, CA, and the Naval Weapons Station (NWS) in Concord, CA, as potential West Coast ports of entry, and MOTSU for a potential East Coast port of entry. This criterion screened out all naval bases and shipyards in the contiguous United States because they do not regularly handle containerized cargo from ocean-going vessels in any significant quantity.

There is great uncertainty associated with attempts to project the future of port activities and possible availability for receipt, handling, and transshipment of foreign research reactor spent nuclear fuel. Many of the features and facilities of ports addressed in Criterion 3 are inextricably related to the likelihood that any given port will meet the minimum requirements for "appropriate" experience in the future. Thus, for example, if a specific port lacks adequate facilities and equipment at present, and there is no identifiable intention of improving the port in the future, it is unlikely that the port will develop the appropriate

APPENDIX D

Table D-2 Commercial Ports with Appropriate Experience Receiving, Handling, and Transshipping Containerized Dry Cargoes^a

<i>U.S. Seaport</i>	<i>Appropriate Experience</i>	<i>U.S. Seaport</i>	<i>Appropriate Experience</i>	<i>U.S. Seaport</i>	<i>Appropriate Experience</i>
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Ports of Entry and DOE Management Sites

1 Appropriate Port Experience:

- Ports routinely handle containerized cargo (at least 20,000 TEUs/yr)

a. Accepted 31 Commercial Ports:

Baltimore, MD*
 Boston, MA
 Charleston, SC
 Eddystone, PA*
 Elizabeth, NJ
 Fernandina Beach, FL
 Freeport, TX
 Galveston, TX
 Gulfport, MS
 Houston, TX
 Jacksonville, FL
 Lake Charles, LA
 Long Beach, CA
 Los Angeles, CA
 Miami, FL
 Newport News, VA*
 New Orleans, LA
 Norfolk, VA*
 Oakland, CA*
 Palm Beach, FL
 Philadelphia, PA
 Port Everglades, FL
 Portland, OR*
 Portsmouth, VA*
 Richmond, VA
 San Francisco, CA
 Savannah, GA*
 Seattle, WA
 Tacoma, WA
 Wilmington, DE
 Wilmington, NC

b. Accepted 3 Military Ports:**

Military Ocean Terminal
 Sunny Point, NC*

 Military Ocean Terminal
 Oakland, CA

 Naval Weapons Station
 Concord, CA

* Database indicates Port has handled SNF or other Type B cask shipments

** Military ports meet 20,000 TEU requirement on a periodic basis, but cycle between high and low work loads based on military demands

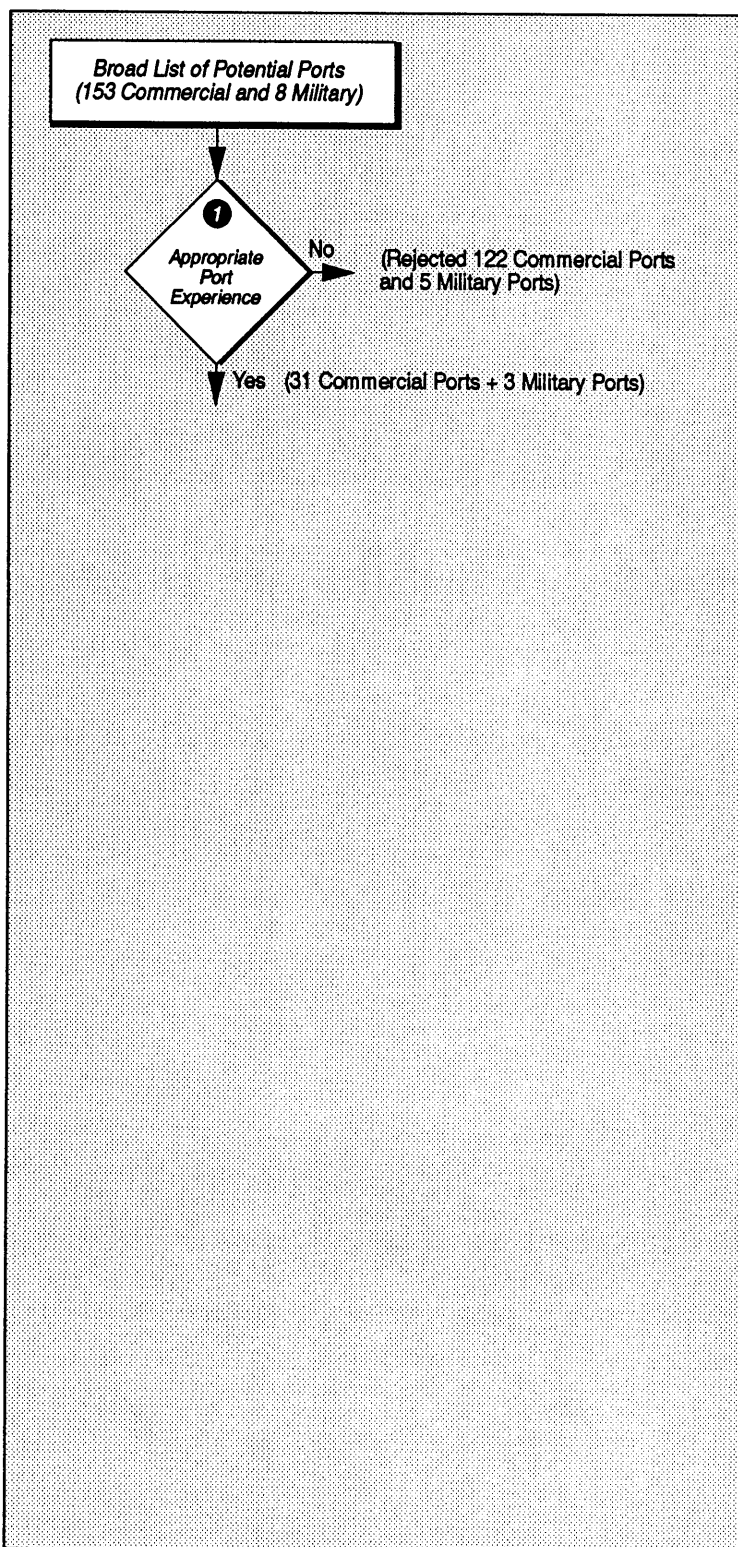


Figure D-2 Screening Ports with Appropriate Experience Criterion

Table D-3 Military Ports with Appropriate Experience Receiving, Handling, and Transshipping Containerized Dry Cargoes

special navigational hazards to ships (including adequate width and depth of water in ship channels). A minimum channel depth (mean low water) of 7.6 m (25 ft) was selected to permit use by at least small to intermediate size vessels.

Less desirable were potential ports that could only be reached by traversing long, narrow and/or winding, or crowded ship channels [e.g., the St. Lawrence seaway to a Great Lakes port or the long passage up the Galveston/Houston ship channel to Houston (which is crowded by oil tankers in the channel and numerous petroleum and petrochemical plants along the channel that could impact on ship safety in the event of a plant or pipeline accident)].

Reliable data on risks associated with transits are difficult to find. In 1991, the U.S. Coast Guard established a national database on ship accidents. The 46 Code of Federal Regulations (CFR) §4.05-1 defines reportable accidents as those events that (1) leave a vessel damaged and presenting a navigational hazard (e.g., loss of propulsion or steering) or affect seaworthiness, (2) cause damage in excess of \$25,000, or (3) result in serious injury or loss of life. Included in the database are allisions (single ship collisions with fixed structures such as buoys, docks, or bridges), collisions (between two vessels while under

Table D-4 Required Maritime Transit Criterion for Selection of Seaports for Foreign Research Reactor Spent Nuclear Fuel Shipments

<i>Seaports</i>	<i>Distance from Open Sea (km)^a</i>	<i>Favorable Transit</i>
Commercial		
Baltimore, MD	240	Yes
Boston, MA	12	Yes
Charleston, SC	11	Yes
Eddystone, PA	120	Yes
Elizabeth, NJ	18	Yes
Fernandina Beach, FL	15	Yes
Freeport, TX	6	Yes
Galveston, TX	16	Yes
Gulfport, MS	30	Yes
Houston, TX	71	No
Jacksonville, FL	11	Yes
Lake Charles, LA	52	No
Long Beach, CA	4	Yes
Los Angeles, CA	5	Yes
Miami, FL	5	Yes
Newport News, VA	40	Yes
New Orleans, LA	160	No
Norfolk, VA	35	Yes
Oakland, CA	15	Yes
Palm Beach, FL	6	Yes
Philadelphia, PA	130	Yes
Port Everglades, FL	2	Yes
Portland, OR	140	Yes
Portsmouth, VA	40	Yes
Richmond, VA	190	No
San Francisco, CA	19	Yes
Savannah, GA	24	Yes
Seattle, WA	5	Yes
Tacoma, WA	5	Yes
Wilmington, DE	100	Yes
Wilmington, NC	38	Yes
Military		
NWS Concord, CA	60	Yes
MOTBA, CA	15	Yes
MOTSU, NC	16	Yes

^aTo convert distance to miles, divide by 1.6.

Thus, while it is preferable to avoid any additional risks associated with the use of general purpose cranes (even though small) by using terminals with equipment designed to handle containerized cargo (an alternative to port container cranes might be the use of combination breakbulk/container vessels with shipboard container cranes that are generally operated by trained and experienced port stevedores), a purpose-built container crane was not determined to be necessary to satisfy this criterion. Military ports also represent a special case, since most do not have such purpose-built container cranes, and use a container spreader attachment when necessary.

② Favorable Transit to Port:

- Port within reasonable distance from the open sea, with favorable transit

a. Accepted 27 Commercial Ports:

Baltimore, MD
 Boston, MA
 Charleston, SC
 Eddystone, PA
 Elizabeth, NJ
 Fernandina Beach, FL
 Freeport, TX
 Galveston, TX
 Gulfport, MS
 Jacksonville, FL
 Long Beach, CA
 Los Angeles, CA
 Miami, FL
 Newport News, VA
 Norfolk, VA
 Oakland, CA
 Palm Beach, FL
 Philadelphia, PA
 Port Everglades, FL
 Portland, OR
 Portsmouth, VA
 San Francisco, CA
 Savannah, GA
 Seattle, WA
 Tacoma, WA
 Wilmington, DE
 Wilmington, NC

b. Accepted 3 Military Ports:

Military Ocean Terminal
 Sunny Point, NC

 Military Ocean Terminal
 Oakland, CA

 Naval Weapons Station
 Concord, CA

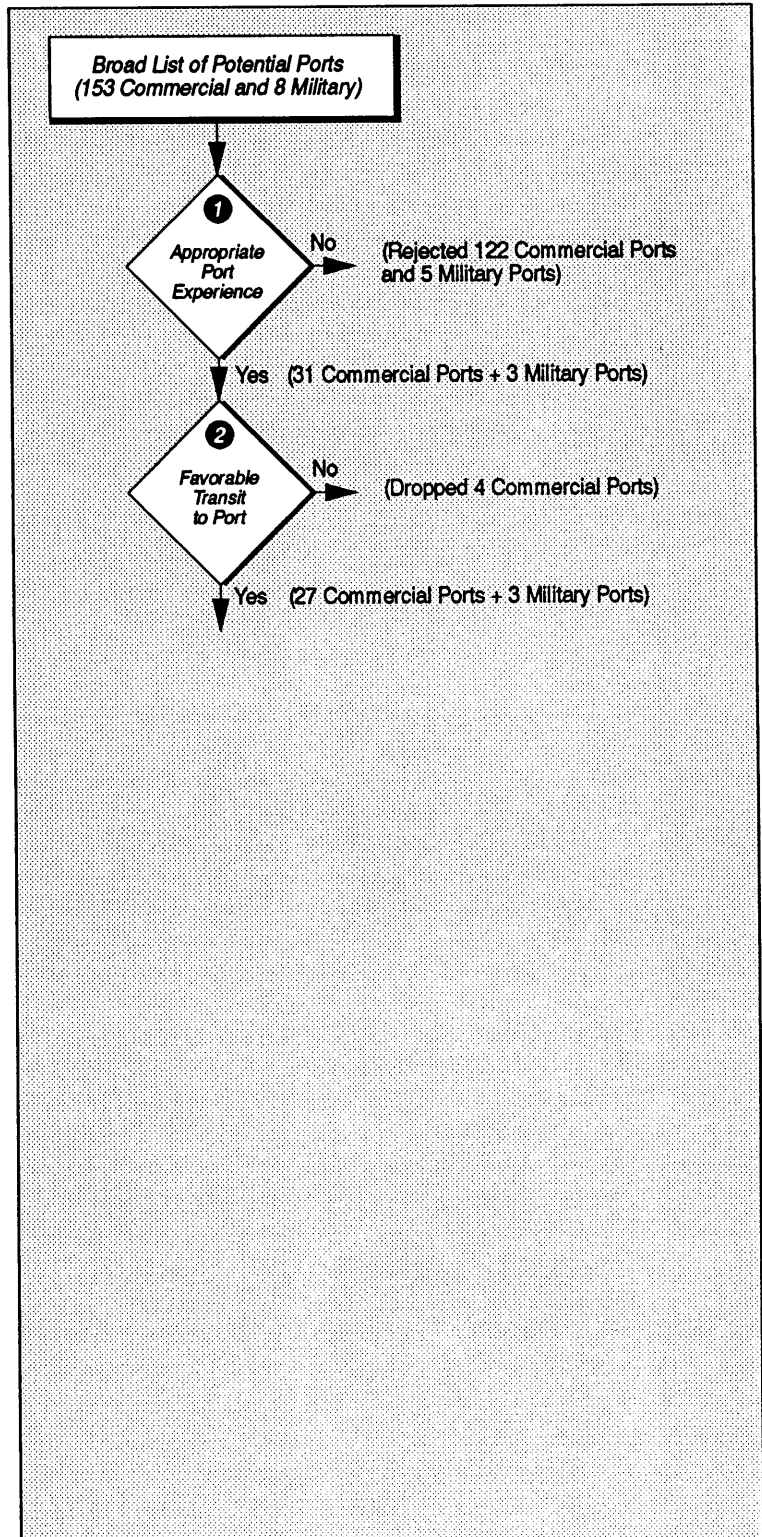


Figure D-3 Screening Ports for Favorable Transit Criterion from Sea to Port

Because containerized spent nuclear fuel requires no special port experience or facilities specific to the handling of radioactive material, ports were not eliminated from consideration because of lack of such experience or facilities.

As noted earlier, there is no reasonable way of determining the future likelihood that currently marginal ports that already have adequate facilities (but simply lack "appropriate experience") will acquire such experience. It depends totally on whether the ports will be able to induce shipping lines to use their facilities. In the area of appropriate facilities, however, there is much less uncertainty in making such determinations, since the planning process for port improvements must be made years in advance in order to allow time for land acquisition, funding, and other approvals before such improvements can be made. Therefore, those ports that have current plans for improvements that might permit their consideration for purposes of this EIS are much easier to identify. As a result, available information relating to future port improvements was studied carefully. Ports with substantial identified improvements or developments during the period analyzed in this EIS include: Baltimore, MD; Boston, MA; Charleston, SC; Fernandina Beach, FL; Gulfport, MS; Jacksonville, FL; San Francisco, CA; Oakland, CA; Long Beach, CA; Naval Weapons Station Concord, CA; Los Angeles, CA; Miami, FL; Mobile, AL; New Orleans, LA; Norfolk, VA; Philadelphia, PA; Port Everglades, FL; New York, NY; Portland, OR; Savannah, GA; Seattle and Tacoma, WA; and Wilmington, DE. Details on these improvements are shown in Attachment D1 to this appendix. All of these ports (except Mobile, AL) currently have both adequate experience and facilities without further improvements. Therefore, no additional ports were identified for foreign research reactor spent nuclear fuel receipt in the future. (Mobile, AL will meet the requirement for experience if it approximately doubles its current container business in the future, but that is too speculative to be useful at this time).

In applying the DOE criteria, it became evident that the majority of the ports that met the first required screening criterion (Appropriate Port Experience) also met these requirements. Application of the Appropriate Facility Criterion retained 25 commercial ports and three military seaports for further analysis. Two commercial ports, Freeport, TX and Palm Beach, FL were dropped due to the application of this criterion. The results of this screening are summarized in Figure D-4.

D.1.9.4 Criterion 4: Ready Access to Intermodal Transportation

A U.S. Merchant Marine Academy Workshop criterion determined to be necessary for safe shipment of spent nuclear fuel was "intermodal access", which means "ready access from a port" to truck and rail routes. It is becoming common practice for ports with intermodal transfer facilities to carry off-loaded containers on special port-owned container handling equipment to a marshalling yard adjacent the terminal, where the containers are loaded onto trucks or rail for shipment to the consignee. Such transfers tend to minimize traffic congestion at shipside by using experienced port personnel and specialized port equipment. These intermodal transfers are increasingly accomplished with purpose-built container handling equipment (straddle carriers, sidelifers, front-end loaders, stackers, and container forklifts) that

③ Appropriate Facilities:

- Adequate crane(s), piers, depth of water alongside, etc.

a. Accepted 25 Commercial Ports:

Baltimore, MD
 Boston, MA
 Charleston, SC
 Eddystone, PA
 Elizabeth, NJ
 Fernandina Beach, FL
 Galveston, TX
 Gulfport, MS
 Jacksonville, FL
 Long Beach, CA
 Los Angeles, CA
 Miami, FL
 Newport News, VA
 Norfolk, VA
 Oakland, CA
 Philadelphia, PA
 Port Everglades, FL
 Portland, OR
 Portsmouth, VA
 San Francisco, CA
 Savannah, GA
 Seattle, WA
 Tacoma, WA
 Wilmington, DE
 Wilmington, NC

b. Accepted 3 Military Ports:

Military Ocean Terminal
 Sunny Point, NC

 Military Ocean Terminal
 Oakland, CA

 Naval Weapons Station
 Concord, CA

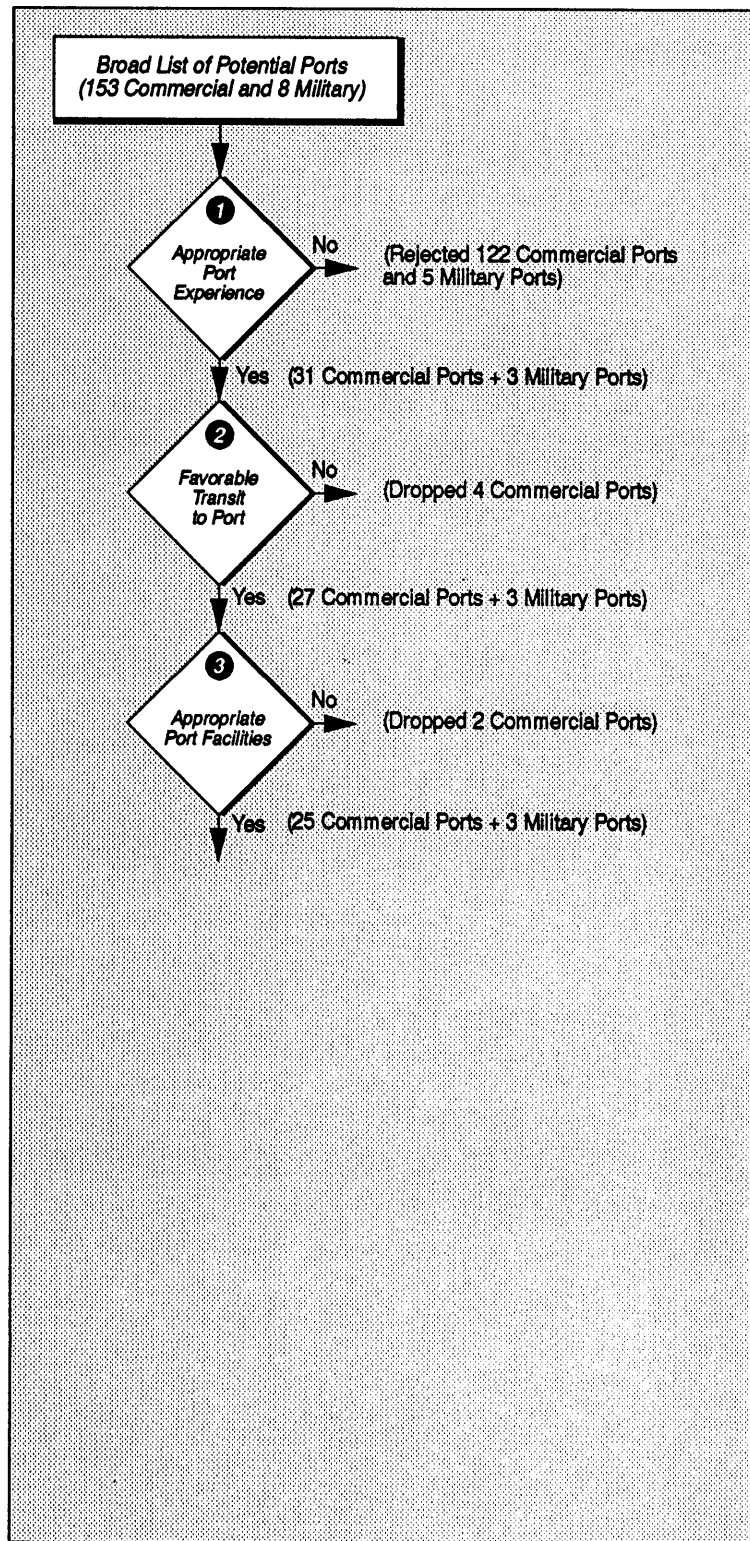
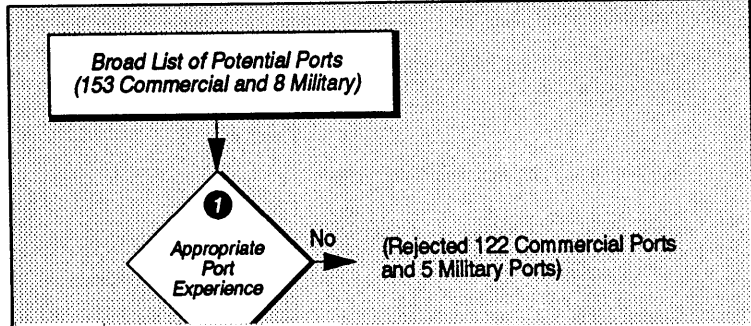


Figure D-4 Screening Ports with Appropriate Facilities Criterion

4 Intermodal Access:

**a. Accepted 25 Commercial Ports
(SRS and ORNL unless
otherwise specified):**

Baltimore, MD
Boston, MA
Charleston, SC
Eddystone, PA



D.1.9.5 Criterion 5: Human Populations

While only dealing with foreign research reactor spent nuclear fuel shipments bound for the Savannah River Site, the Federal court ruling discussed in Section D.1.3 indicates that the courts consider port populations to be an important ingredient in the National Environmental Policy Act (NEPA) process for assessing the range of reasonable port alternatives.

NEPA requires that DOE consider a range of reasonable alternatives for potential ports of entry. On the other hand, the National Defense Authorization Act port selection factors required that, if economically

feasible and to the maximum extent practicable, ports of entry for foreign research reactor spent nuclear fuel bound for the Savannah River Site have the lowest human populations in the area surrounding the port. While the National Defense Authorization Act was written specifically to regulate the receipt and storage of foreign research reactor spent nuclear fuel at the DOE's Savannah River Site, DOE elected to apply this criterion in identifying ports of entry for all five potential sites, to the maximum extent practicable.

DOE has considered a number of potential definitions of "lowest human populations" and resulting models that might be used to satisfy the National Defense Authorization Act lowest population factor (NDAA, 1993). These include using the same approach used in the Urgent Relief Environmental Assessment (DOE, 1994d), and variations that might be useful for identifying ports for inclusion in this EIS. A description of the various approaches that were considered are provided in Attachment D3 to this appendix.

As shown in the Urgent Relief Environmental Assessment (DOE, 1994d) and this EIS (Chapter 4), public risk is driven not only by port populations, but by the populations within the immediate proximity of truck and rail shipments from each port to each management site. For each selected port and each selected mode of overland transport (truck or rail), the total "affected" population represents a unique population surrounding the port plus those along the transport route to each of the five potential DOE management sites. DOE considered the affected populations outside the immediate port vicinity along the routes to the management sites to be as important for protection of public health and safety as those within the vicinity of the port terminals, for both incident-free transport and a range of potential accidents.

DOE evaluated port populations within the radii of three distances: 1.6 kilometers (km) [1 mile (mi)], 8.0 km (5 mi), and 16 km (10 mi). These populations are shown in Table D-5. DOE expects that the 1.6 km (1 mi) radius population would include resident members of the public immediately outside the port who would be the most likely to be affected by severe accidents and incident-free impacts. In addition, the radioactivity, which is hypothesized to be released from a very severe accident (long-term fire leading to severe cask damage), would be lofted high into the air and would not normally produce peak ground-level air concentrations until well outside the 1.6 km (1 mi) radius. Therefore, the 1.6 km (1 mi) population was not considered adequate to reflect the population criterion.

The population within a 16 km (10 mi) radius was selected to be consistent with the results of analyses of severe hypothetical accidents described in Section D.5 of this appendix. For severe accidents in ports, the maximum radiation dose to an individual located 16 km (10 mi) from the port is typically much lower than the dose to the maximally exposed individual. However, analyses of the potential impacts of severe accidents in a range of port populations show that the average dose to members of the public within a 16 km (10 mi) radius of the port is higher than the average per capita dose for any of the larger radii around the port for typical (i.e., 50th percentile) meteorology and typical dry deposition and fallout patterns. Further, as discussed in section D.5.4, most of the population within the 16 km (10 mi) radius is within the 16 km (10 mi) radius of the port.

Table D-5 Total Populations within Three Distances of Selected U.S. Ports

<i>Name of the Port</i>	<i>Within 1.6 km (1 mi)</i>	<i>Within 8 km (5 mi)</i>	<i>Within 16 km (10 mi)</i>
NWS Concord, CA	14	71,152	381,070
MOTSU, NC	21	960	7,995
Tacoma, WA	94	172,124	511,575
Portland, OR	280	69,039	356,064
Elizabeth, NJ	378	596,076	3,223,038
MOTBA, CA	419	312,133	1,288,699
Jacksonville, FL	523	72,313	334,212
Seattle, WA	557	270,145	753,296
Wilmington, DE	753	166,165	381,502
Gulfport, MS	761	50,218	113,153
Baltimore, MD	818	352,730	1,182,024
Savannah, GA	860	30,845	155,166
Long Beach, CA	1,025	270,336	1,014,418
Charleston, SC	1,550	81,874	233,424
Oakland, CA	1,901	296,661	1,387,611
Miami, FL	2,043	251,551	833,057
Fernandina Beach, FL	2,086	11,787	32,952
Portsmouth, VA	2,554	269,314	665,700
Newport News, VA	2,637	86,993	430,757
Wilmington, NC	2,690	60,308	115,057
Los Angeles, CA	2,918	362,397	1,124,493
Norfolk, VA	2,982	227,290	681,864
Boston, MA	3,084	495,679	1,466,233
Port Everglades, FL	3,927	175,320	714,176
Philadelphia, PA	5,878	50,687	1,915,775
Eddystone, PA	6,179	204,969	827,564
Galveston, TX	8,115	49,175	73,322
San Francisco, CA	9,671	592,869	1,265,529

even smaller doses beyond 16 km (10 mi). Therefore, DOE selected the 16 km (10 mi) radius population to represent the port populations most likely to be impacted by both incident-free transport and the entire range of potential port accidents.

It should be noted that while the populations within the 16 km (10 mi) radius include the populations within 0.8 km (0.5 mi) of the transportation route out to 16 km (10 mi) from the port and result in some double-counting of populations, the results provide only somewhat conservative estimates of the total affected population for each port/management site combination considered.

The statistical distribution of these combined populations for truck transport is shown in Figure D-6. The distribution exhibits some skewing due to a few very large port/site populations, such as around Boston, MA and Elizabeth, NJ. The statistical distribution of combined populations for rail transport is shown in Figure D-7, and again exhibits some skewing due to a few very high population ports. These port/site populations are not clearly normal and are better fit by a Poisson (so-called rare event) distribution, which is often the case for small sample sizes. However, for purposes of developing a systematic and fair method (i.e., one with minimal subjectivity) for evaluating port/site populations, DOE assumed, given the large uncertainty and variances for the small sample sizes for each port/site combined population, that the combined populations for truck transit and the combined populations for rail transit are approximately normal. The port/site population distributions for each of the five management sites (truck and rail routes) are shown in Figures D-8 through D-17, with the bounds associated with the mean plus and minus one standard deviation marked for reference.

For purposes of identifying an acceptable range of ports of entry for the receipt of foreign research reactor spent nuclear fuel, DOE assumed that port/site population combinations greater than approximately one standard deviation above the mean would not be desirable (i.e., about 84 percent of the port/site populations would exhibit statistically lower populations). Thus, the range of ports would include most of the 28 ports being considered, but avoid the extremely large populations around Boston, MA, Elizabeth, NJ, and Philadelphia, PA.

From the remaining 25 ports, DOE assumed that population combinations below the mean combined population would meet the low population criterion while combined populations above the mean would not. As seen in Figures D-8 through D-17, some unique port/site populations would be acceptable for several potential management sites, while other populations would have very limited utility. The potential usefulness of low population ports in relation to this EIS is addressed in Section D.1.9.6. This screening would result in the elimination of an additional five commercial ports and one military port from the list. These commercial ports are Baltimore, MD, and Long Beach, Los Angeles, Oakland, and San Francisco, CA. The military port is Military Ocean Terminal Bay Area in Oakland, CA. The results of the population screening are summarized in Figure D-18.

As previously discussed, the position of maritime experts (USMMA, 1994) is that all of the ports evaluated under the DOE-developed criteria for populations could safely receive and tranship foreign research reactor spent nuclear fuel to all five of the potential DOE management sites. Further, the EIS analyses show that the conservatively calculated impacts would be extremely low. The identification of a smaller number of preferred ports of entry is driven by the requirements of the National Defense Authorization Act, not by any significant safety issues.

As promised in the Urgent Relief Environment Assessment, DOE has also considered future population growth near potential port facilities over the time period considered in this EIS. Year 2010 estimates of projected growth from the 1990 census populations were provided by the states hosting the selected ports and other sources where necessary. Population growth patterns in port cities are continuously changing in ways that cannot be accurately forecast 10 or more years into the future. Nevertheless, the projected port populations based on these growth factors were scrutinized to be sure that no unacceptably large growth would occur around the list of ports selected under the DOE "lowest human population" criterion. The port growth factors used for projecting potential future impacts of port accidents are summarized in Attachment D2 to this appendix, and were used to make final port selections, where appropriate, as discussed in the next section.

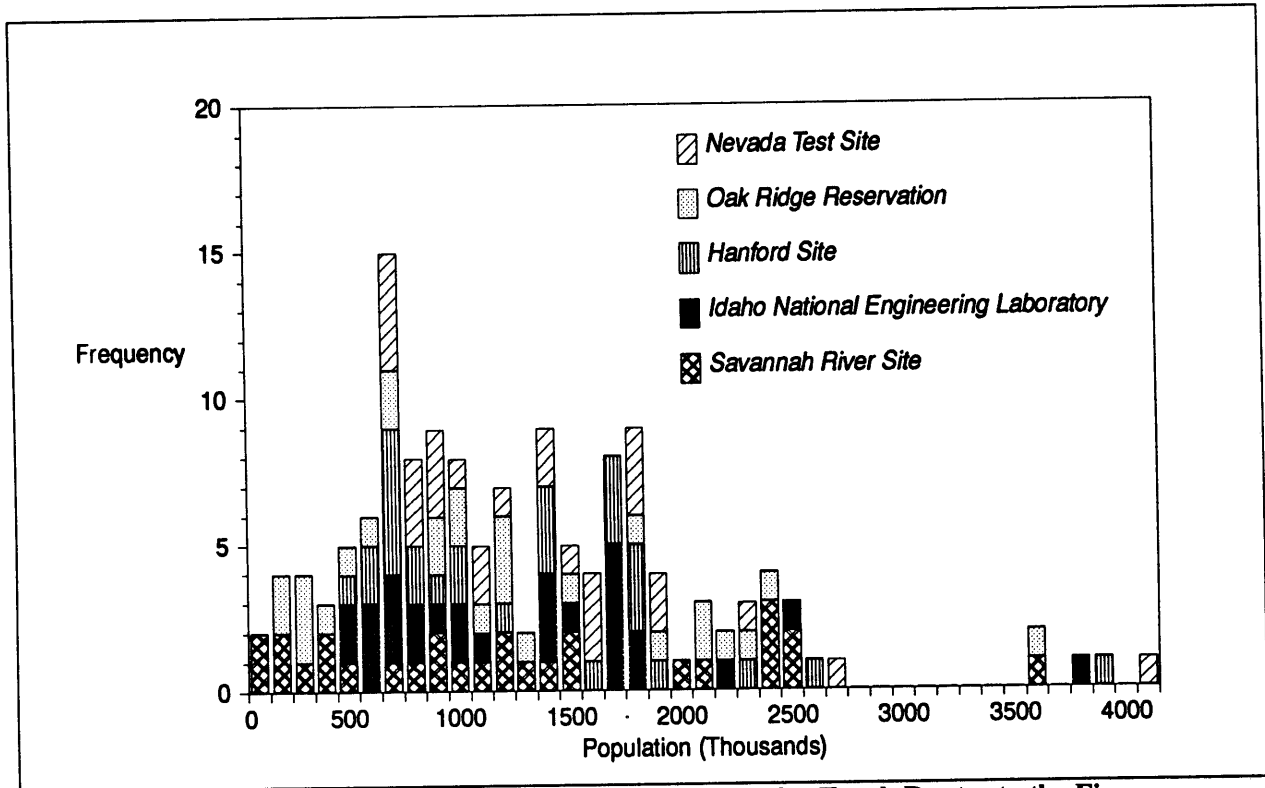


Figure D-6 Distribution of Port/Site Populations for Truck Routes to the Five Management Sites

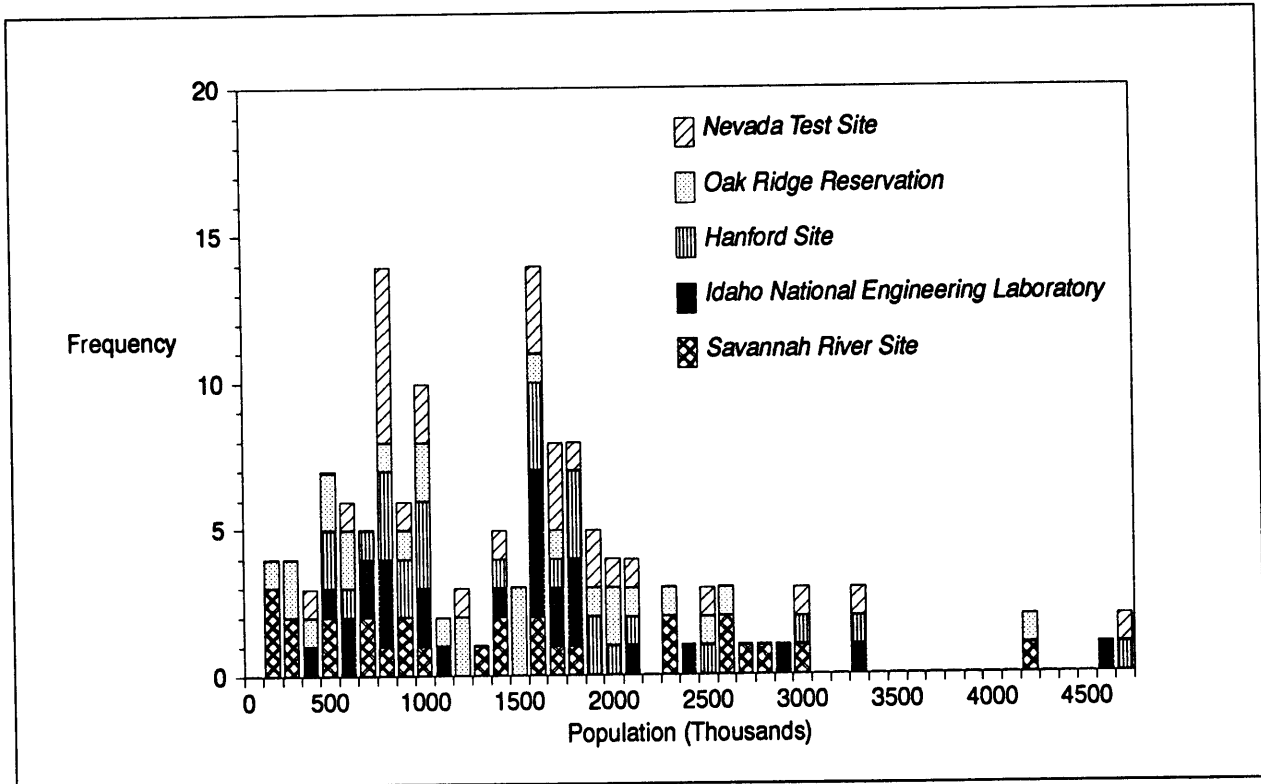


Figure D-7 Distribution of Port/Site Populations for Rail Routes to the Five Management Sites

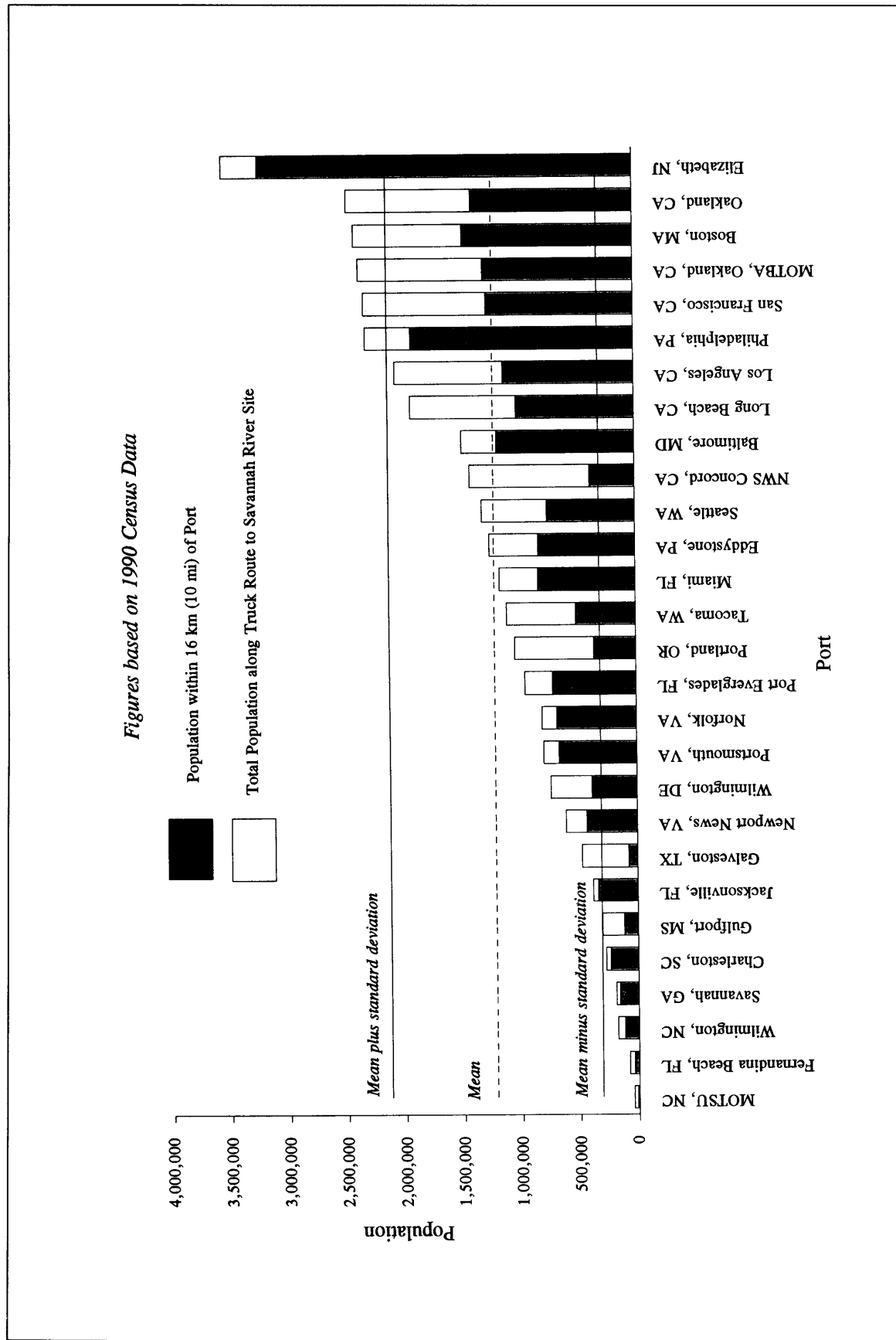


Figure D-8 Population Distribution for Savannah River Site by Truck

Figures based on 1990 Census Data

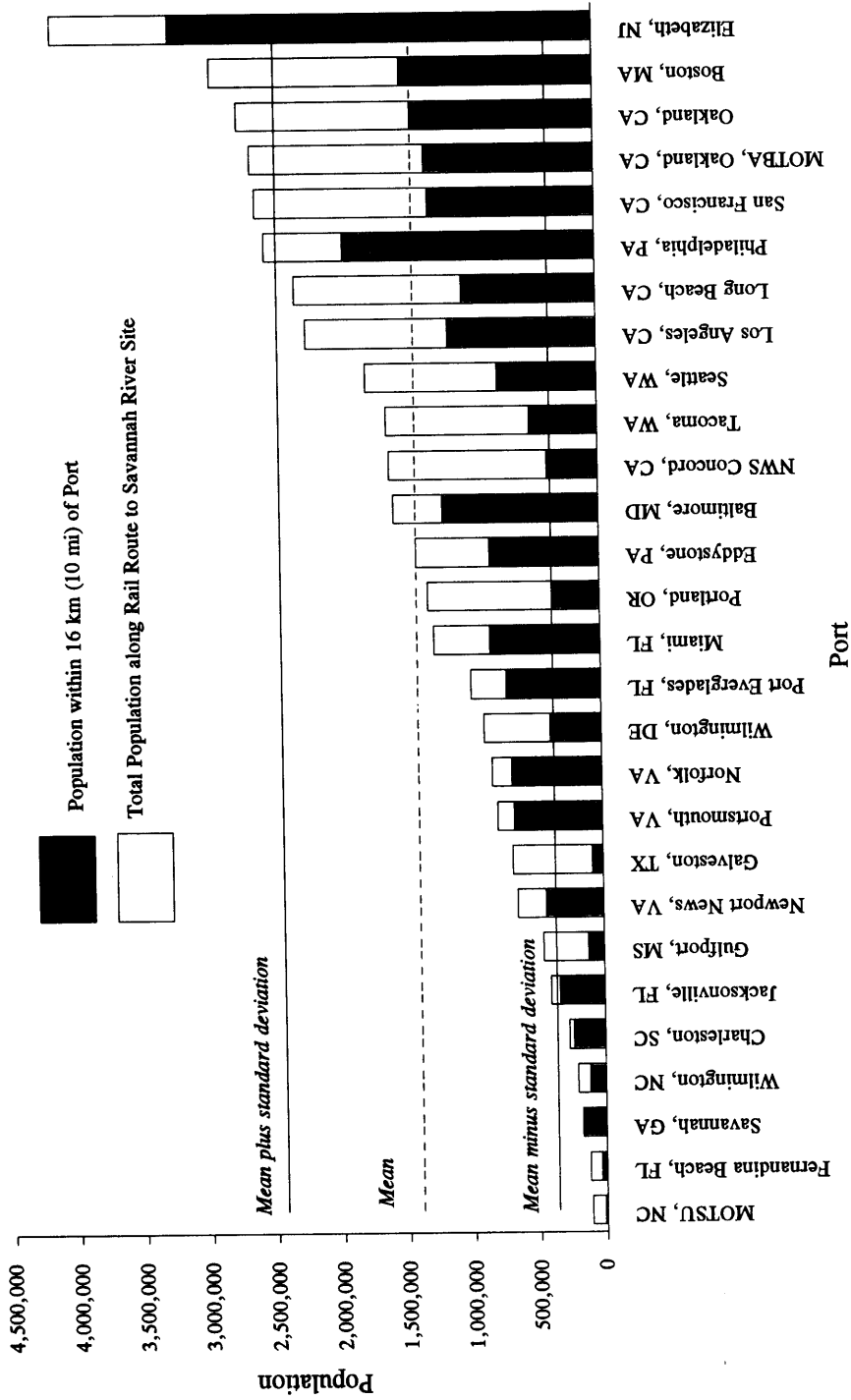


Figure D-9 Population Distribution for Savannah River Site by Rail

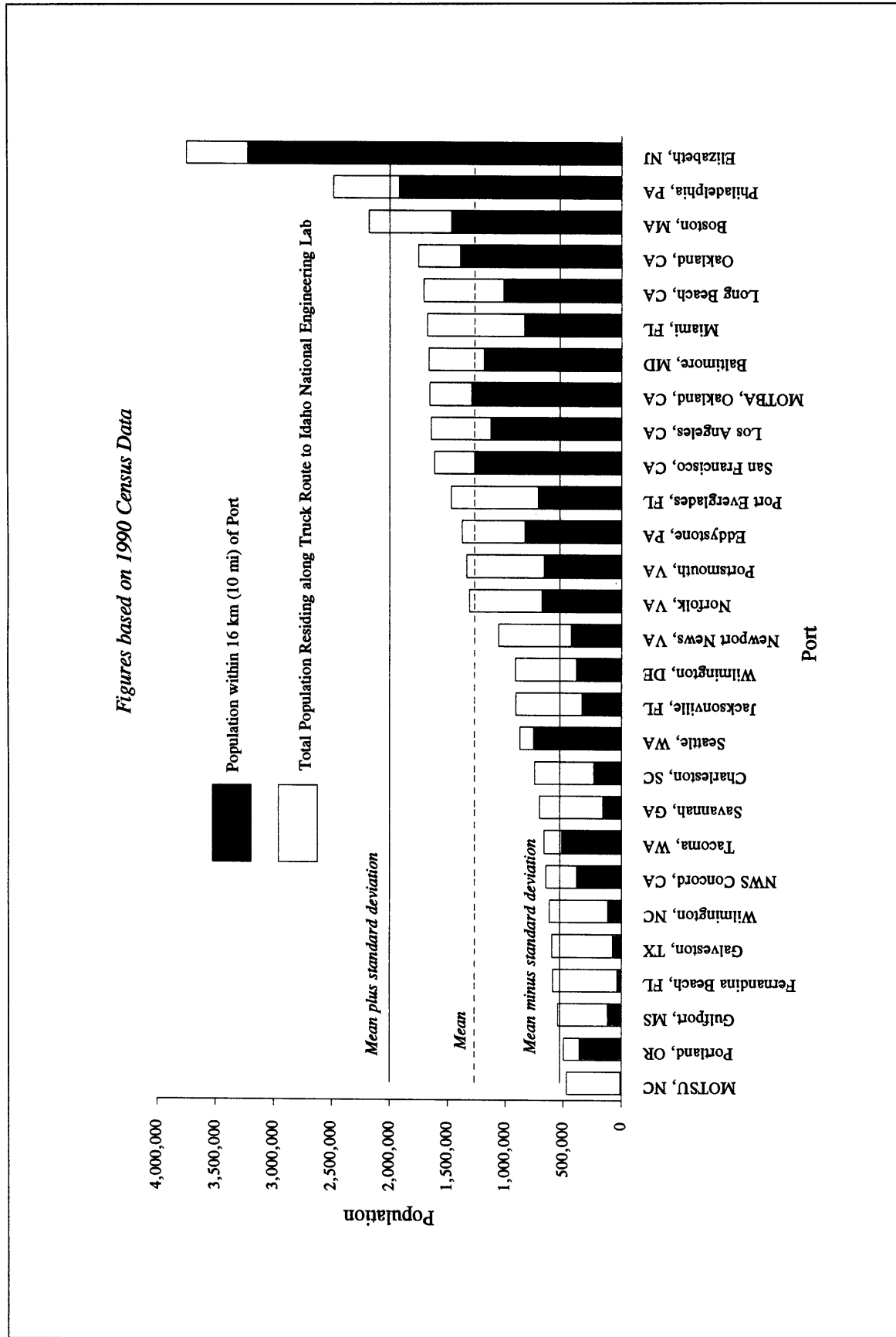


Figure D-10 Population Distribution for Idaho National Engineering Laboratory by Truck

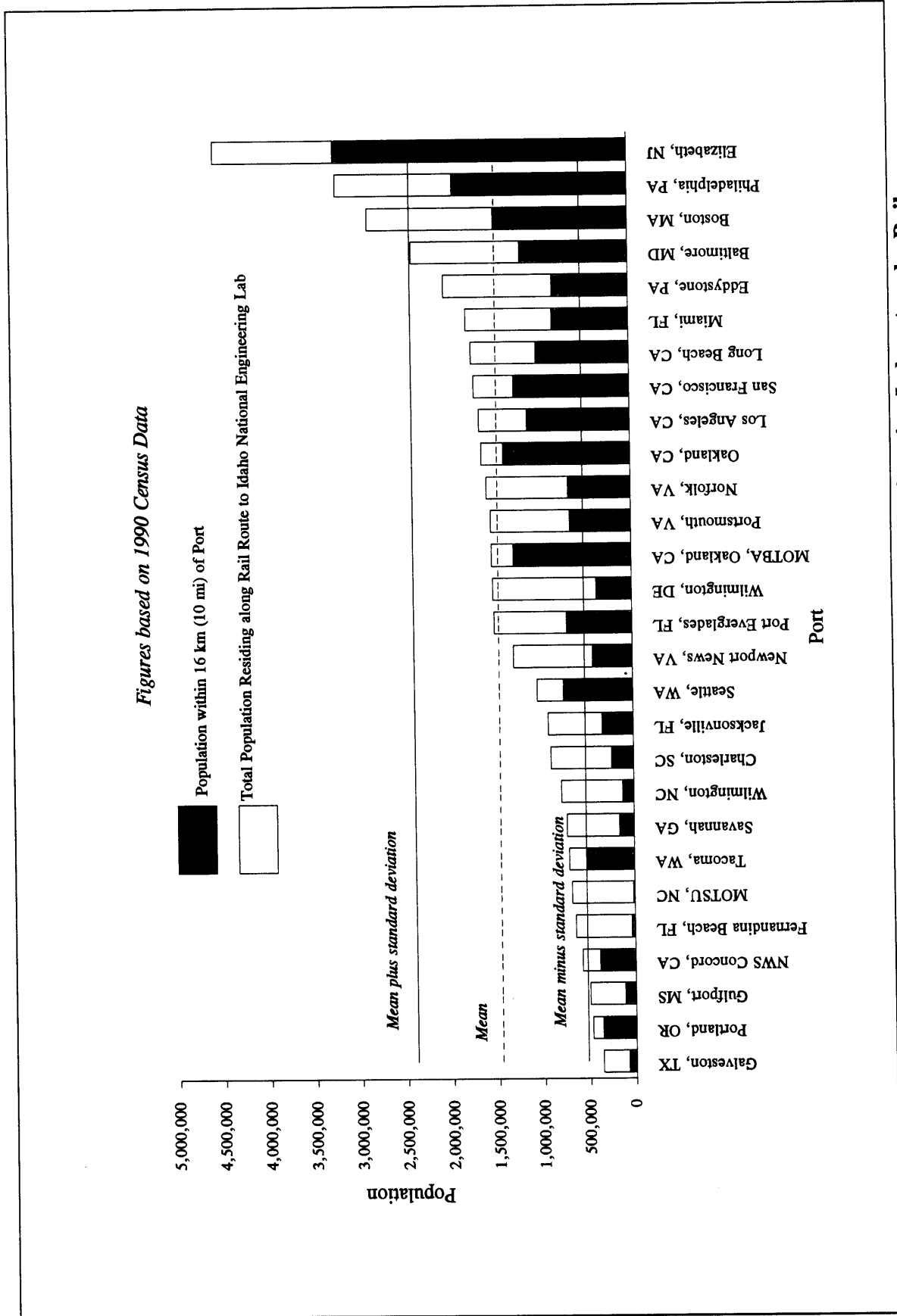
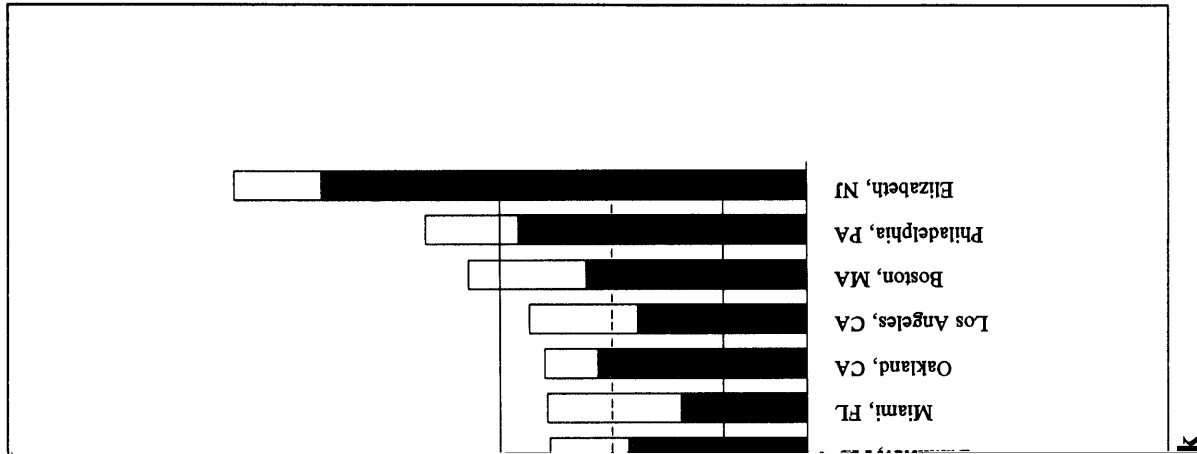


Figure D-11 Population Distribution for Idaho National Engineering Laboratory by Rail

SELECTION AND EVALUATION OF POTENTIAL PORTS OF ENTRY



Figures based on 1990 Census Data

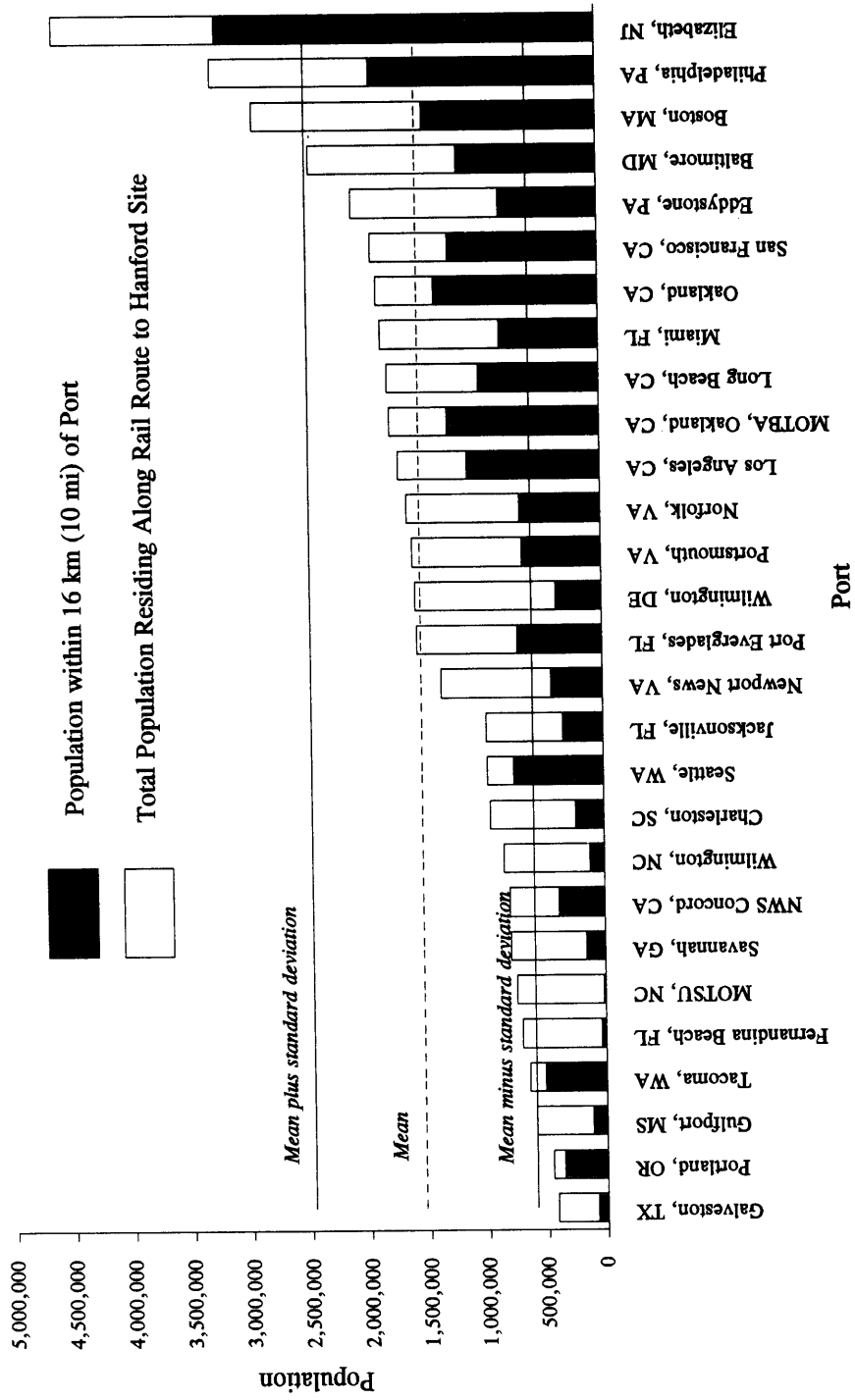


Figure D-13 Population Distribution for Hanford Site by Rail

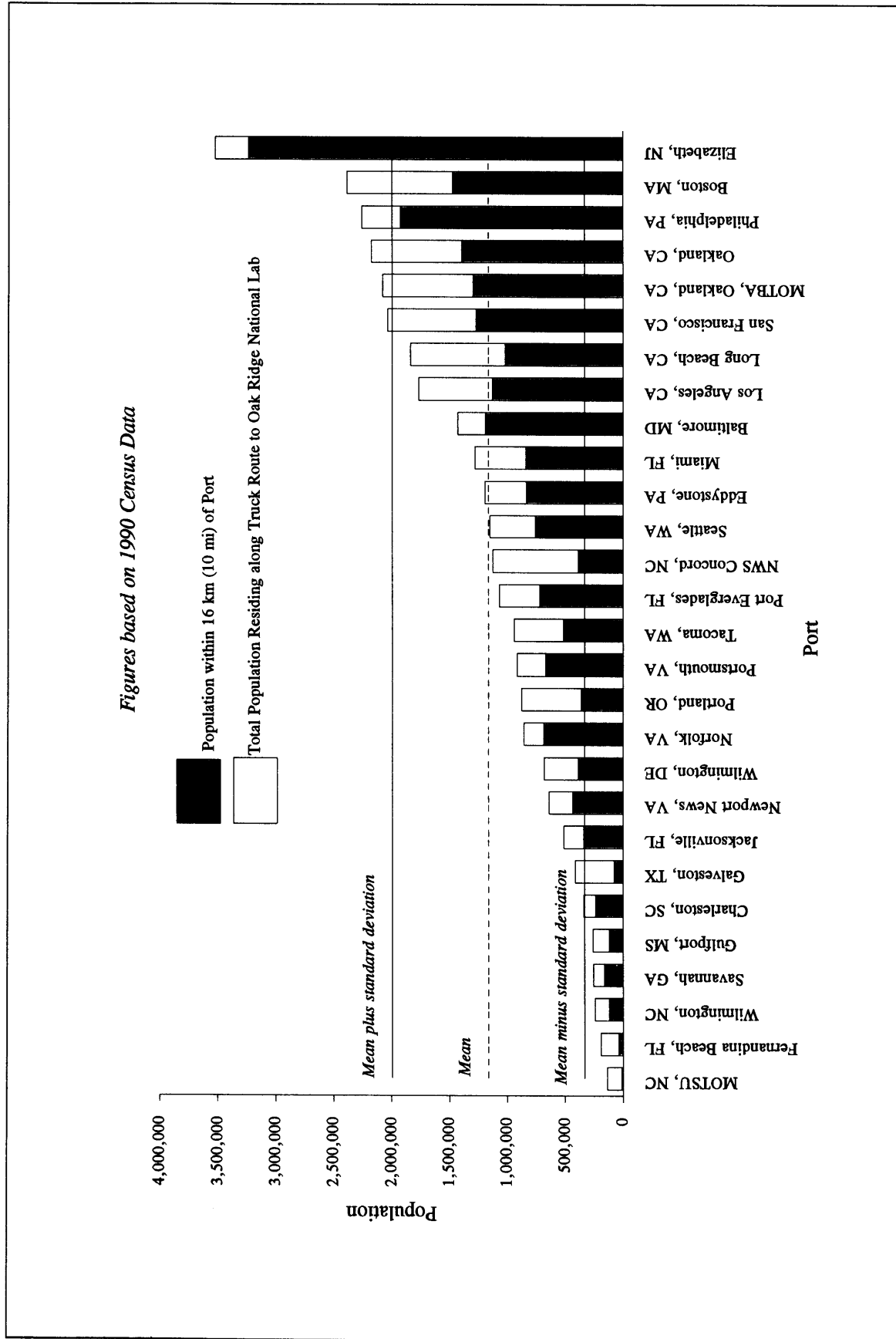


Figure D-14 Population Distribution for Oak Ridge Reservation by Truck

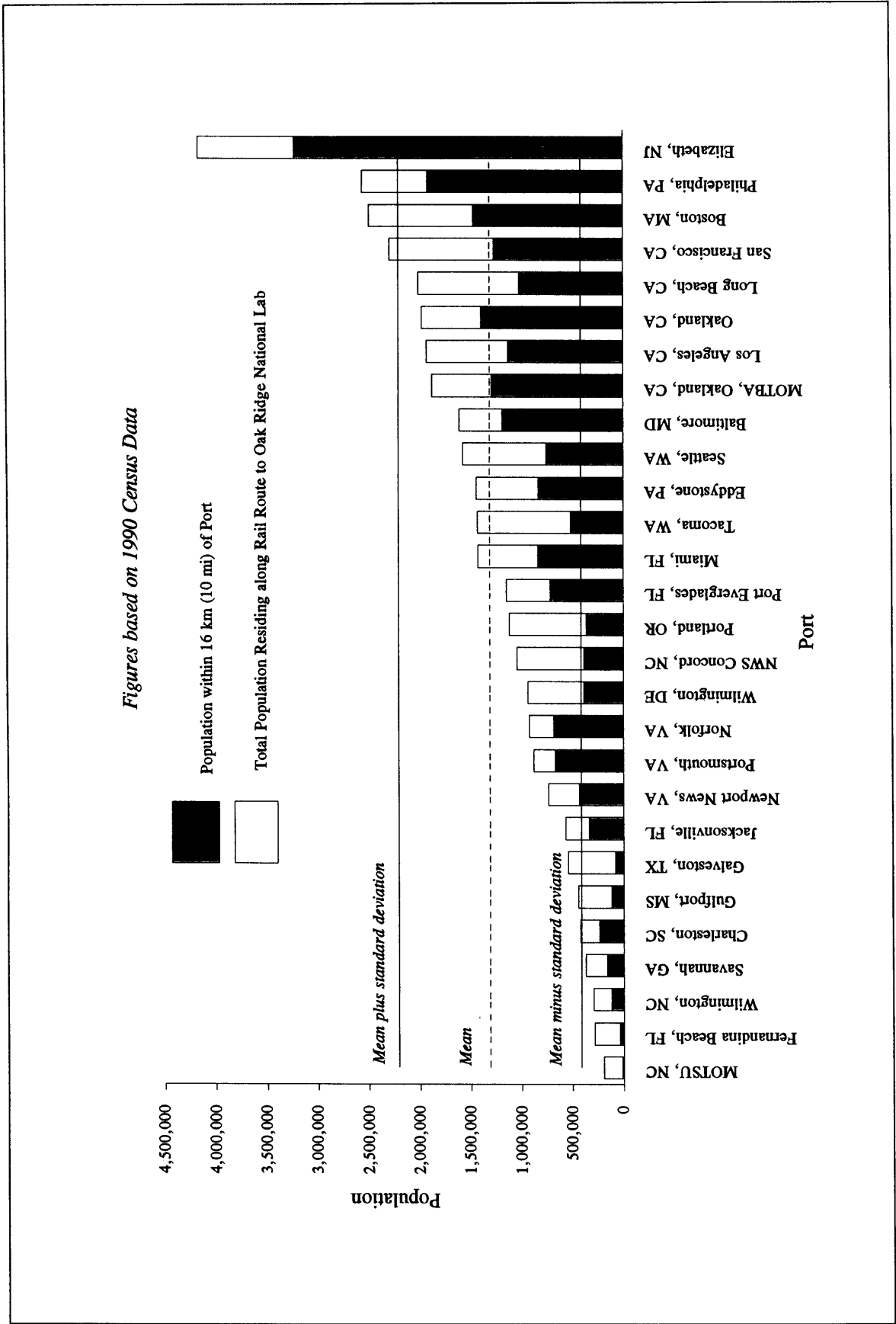


Figure D-15 Population Distribution for Oak Ridge Reservation by Rail

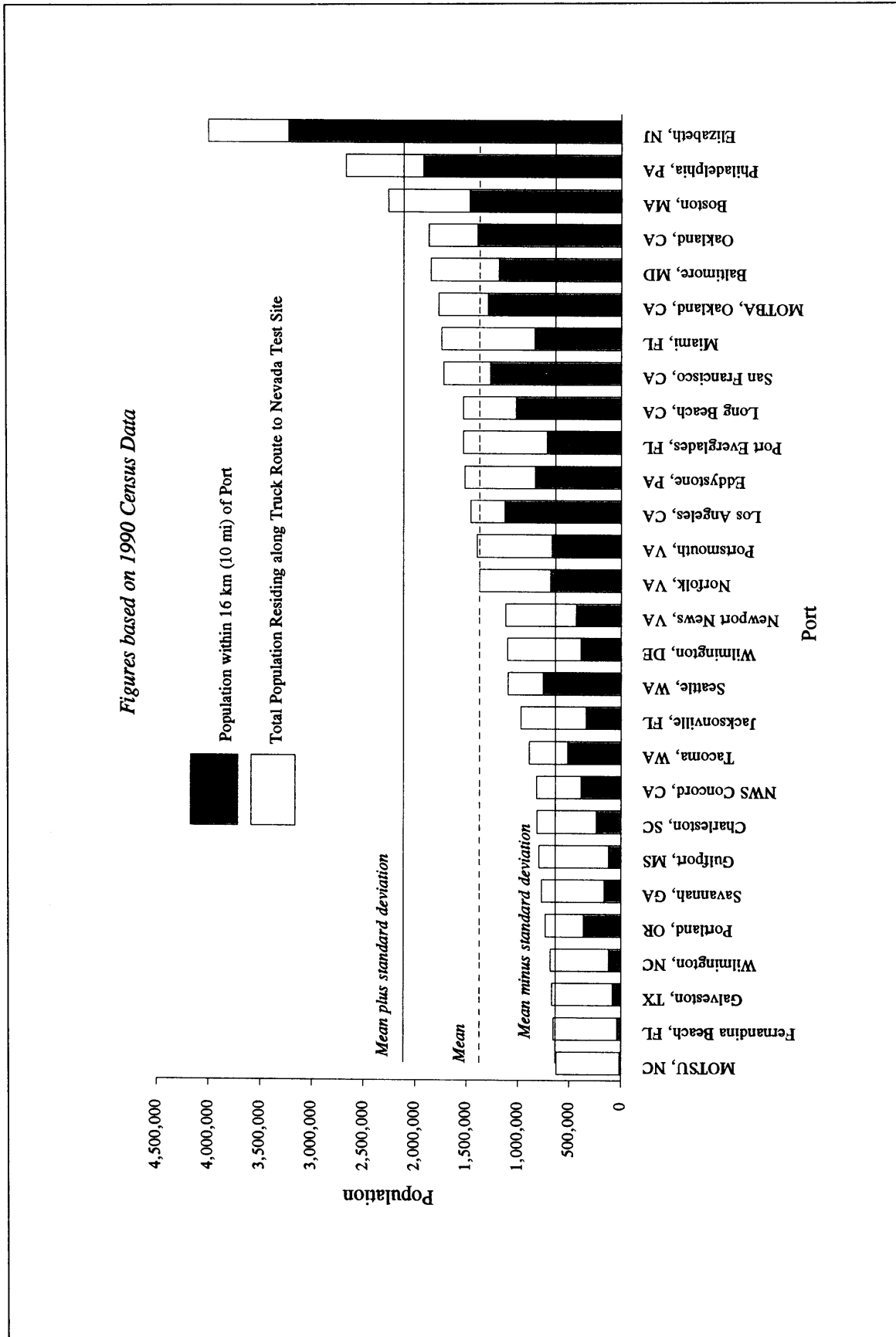


Figure D-16 Population Distribution for Nevada Test Site by Truck

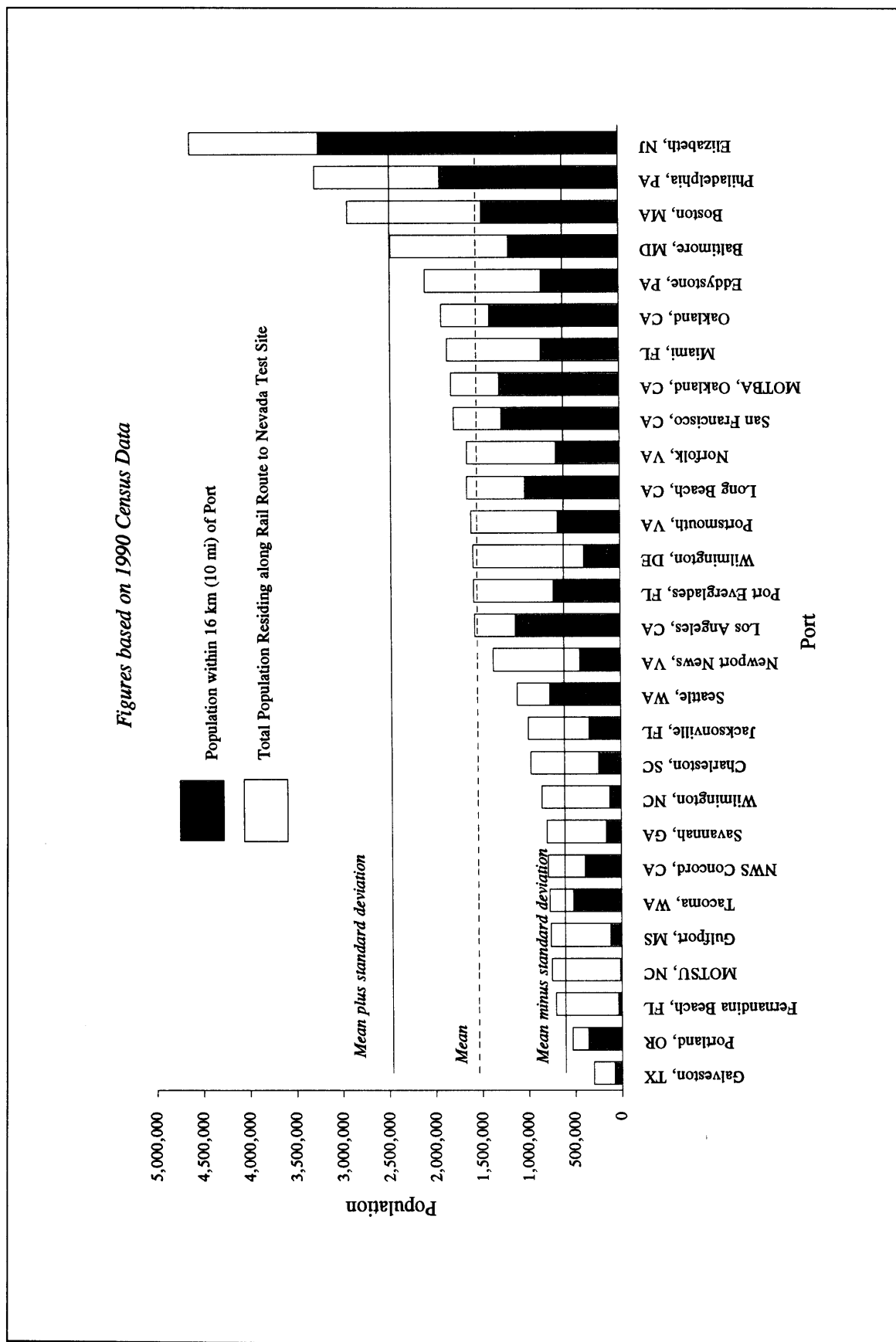


Figure D-17 Population Distribution for Nevada Test Site by Rail

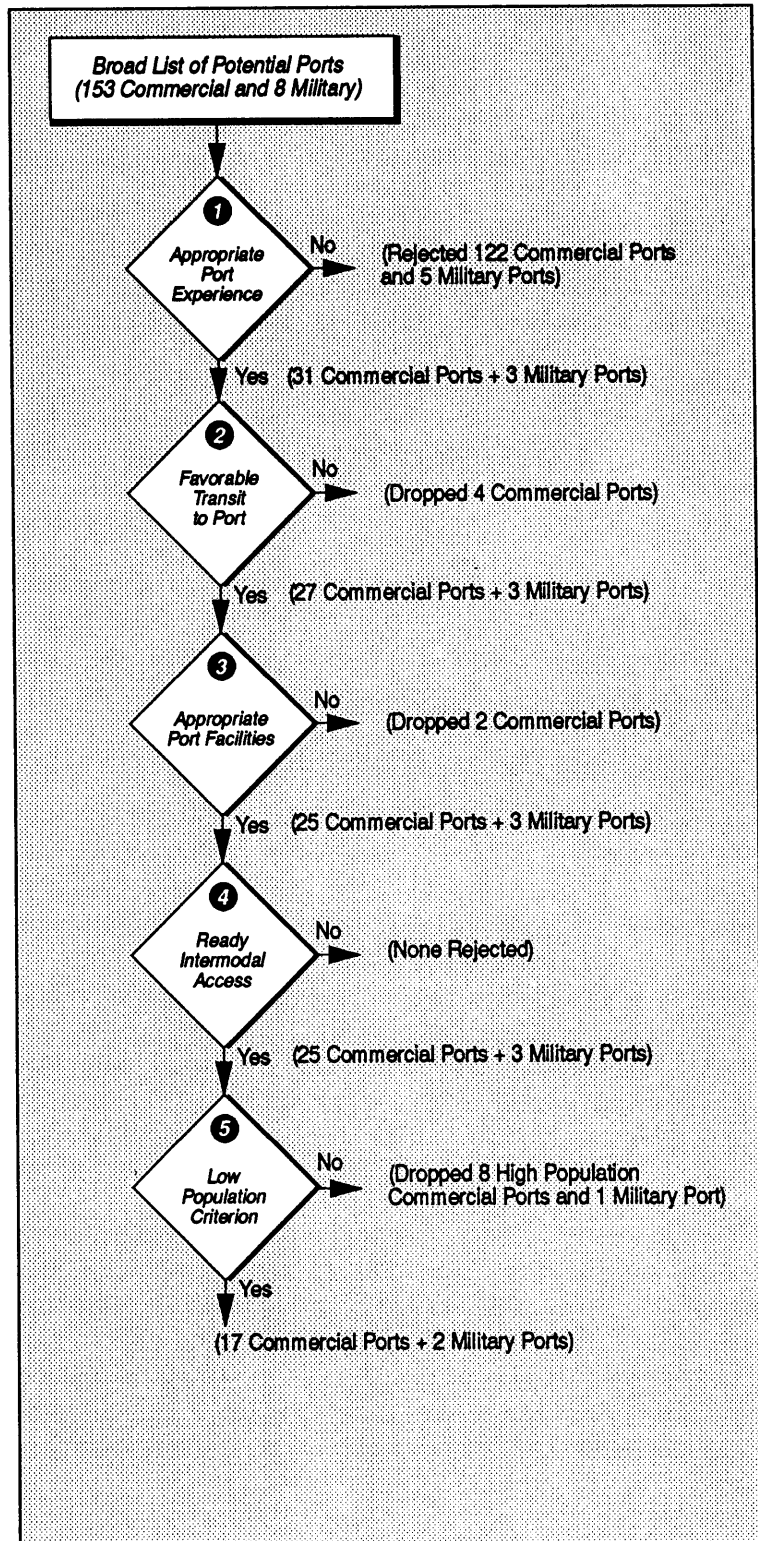
5 Low Population Criteria:

a. Accepted 17 Commercial Ports:

Charleston, SC
 Eddystone, PA
 Fernandina Beach, FL
 Galveston, TX
 Gulfport, MS
 Jacksonville, FL
 Miami, FL
 Newport News, VA
 Norfolk, VA
 Port Everglades, FL
 Portland, OR
 Portsmouth, VA
 Savannah, GA
 Seattle, WA
 Tacoma, WA
 Wilmington, DE
 Wilmington, NC

b. Accepted 2 Military Ports:

Military Ocean Terminal
 Sunny Point, NC
 Naval Weapons Station
 Concord, CA



D.1.9.6 Desirable Port Attributes

As discussed in Section D.1.9, there are a number of desirable attributes that were not important enough individually to reject an otherwise acceptable port, but have been collectively used to select proposed ports from the list of ports found acceptable under the other DOE criteria. As an element of desirable attributes, DOE examined the likely usefulness of ports for foreign research reactor spent nuclear fuel shipments to any of the five DOE management sites.

The term "usefulness," as used here, is a relative term wherein the relative numbers of scheduled shipping lines and the types of ships that service each port and the countries served by those lines, are compared for two or more otherwise acceptable ports for purposes of selecting the best of that group. This helped to

select the ports most likely to be useful in relation to this EIS. This information is shown in Table D-6.

In using these factors, the Ports of Newport News, Norfolk, and Portsmouth, VA, are examined as a single port: Hampton Roads, VA. Table D-6 shows the results of the evaluation of the low population ports for usefulness. The limited usefulness of a port for truck or rail access and service to the potential foreign research reactor spent nuclear fuel management sites eliminated the Ports of Eddystone, PA, Miami and Port Everglades, FL, Wilmington, DE, and Seattle, WA from further consideration.

DOE also identified the most desirable attributes of the remaining ports, such as terminals that do not have conflicting activities nearby (e.g., cruise ship lines, large tourist populations, large petroleum or

**Table D-6 Relative Usefulness of Low Population Ports for Foreign Research
Reactor Spent Nuclear Fuel Shipments**

<i>Ports-of-Entry</i>	<i>Relative Usefulness by Storage Site</i>					<i>Relative Usefulness by Foreign Research Reactor Spent Nuclear Fuel Shippers</i>	
	<i>SRS</i>	<i>ORR</i>	<i>INEL</i>	<i>HS</i>	<i>NTS</i>	<i>Conventional Carriers</i>	<i>Charters</i>
<i>Commercial</i>							
<i>East Coast</i>							
Charleston, SC (Wando Terminal)	T&R	T&R	T&R	T&R	T&R	Europe, Far East, Japan, Australia	Yes
Eddystone, PA	R	No	No	No	No	Central/South America	Yes
Fernandina Beach, FL	T&R	T&R	T&R	T&R	T&R	South/Central America, Mediterranean (monthly)	Yes
Hampton Roads, VA	T&R	T&R	T&R	T&R	T&R	Most of the world	Yes
Jacksonville, FL	T&R	T&R	T&R	T&R	T&R	Most of the world	Yes
Miami, FL	T&R	No	No	No	No	Central/South America, Mediterranean, Mexico, Far East	Yes
Port Everglades, FL	T&R	T&R	No	No	No	South American, Northern Europe,	Yes

accidents, since many of the features are the same (e.g., identification of decisionmakers, first responders, and support personnel to mitigate impacts of fires, etc.). In addition, for ports that have no specific response plans for spent nuclear fuel accidents in port, DOE could provide assistance in the development of radiological emergency response plans (in addition to existing hazardous cargo emergency response capability) and training at such ports in the event they were ultimately selected for foreign research reactor spent nuclear fuel shipments. Thus, appropriate plans and training would likely be in place prior to actual receipt of any such shipments. Ports having current emergency response capabilities were considered more desirable than those that do not.

Spent Nuclear Fuel Handling Experience

The National Defense Authorization Act would also require, “to the maximum extent practicable,” that the ports selected for receipt of foreign research reactor spent nuclear fuel have spent nuclear fuel handling experience. At the present time, there are only a few ports in the United States with relatively recent experience handling either spent nuclear fuel or high-level radioactivity in Type B casks. As a result, this criterion, while desirable, unnecessarily restricts considerations to an unacceptably small group of potential ports, and strictly applied, could preclude shipments of spent nuclear fuel from some of the countries being considered under this EIS except by chartered ship. However, because all containerized cargoes are handled in the same manner as the containerized spent nuclear fuel would be handled, DOE concluded that current experience (especially any involving routine handling of potentially hazardous cargoes, or other radioactive cargoes in Type B casks) is much more important for public safety than foreign research reactor spent nuclear fuel handling experience in years past. This is especially true since the trained longshoremen are likely to have changed jobs, ports, or retired during the several years between the last shipments of spent nuclear fuel and the potential onset of future shipments under this EIS.

In addition, ports that have satisfied the “appropriate experience” and “port facilities” criteria are expected to be fully capable of currently handling spent nuclear fuel containers, and would gain experience as the program progressed.

Environmental Concerns Near Ports

Marine areas, immediately surrounding most of the ports considered in this selection process, tend to be severely impacted as a result of necessary periodic dredging or construction of new port facilities, including turning basins, high volumes of marine traffic, and routine port activities. As a result, ports generally are no longer environmentally sensitive areas within the context of NEPA. However, consistent with U.S. Merchant Marine Academy Workshop recommendations and in response to public comments, DOE decided that when special protected or sensitive areas were identified nearby the terminal(s) being considered, these areas would be identified in the EIS and used for final port identification as appropriate. No serious issues have been identified in the immediate vicinity of any ports selected under the DOE low population criterion review, with the possible exception of the NWS Concord, CA and Fernandina Beach, FL.

Environmental Concerns from Severe Natural Phenomena

Other factors that were considered desirable attributes for ports include average or lower risks from severe weather (e.g., extremely high winds, hurricanes, etc.) or other natural phenomena (e.g., seiches, earthquakes, volcanism, etc.). These attributes are not expected to be of great significance in practice, since the time involved with potential receipt and transshipment of containerized spent nuclear fuel represents such an extremely short period of risk (typically less than 24 hours), that the probability of

severe natural phenomena impacting foreign research reactor spent nuclear fuel shipments is vanishingly small. Further, some natural events, such as hurricanes, can often be avoided. However, these characteristics were examined in conducting the port evaluation.

Separation of Port Facilities from Urban Populations

The following desirable characteristics are examined:

- Terminals used for spent nuclear fuel shipments should be physically separated from densely populated city centers (by several kilometers if possible) to help ensure that the general public would be unlikely to be exposed to significant radiation doses from either incident-free transport or accidents within the port (e.g., cask drops, fires, or truck or rail accidents, etc.).
- Transport of spent nuclear fuel through large, densely-populated, congested areas around the port should be avoided where practical.

These geographic/demographic characteristics, while not explicitly addressed in the evaluation of “lowest human populations” for ports, are implicitly included in the 16 km (10 mi) radius populations used for screening ports. While absence of these characteristics would not necessarily eliminate the use of such ports under this EIS, DOE reviewed these ports to determine if there were terminals or piers within the port that provided these characteristics. In many cases, development of new port facilities in recent years has resulted in specific terminals and/or piers that meet all of the required criteria (USMMA, 1994, and NDAA, 1993), and that also have most or all of the additional desirable characteristics (e.g., the Wando Terminal in Charleston, SC, the Blount Island Terminal in Jacksonville, FL, or Terminal T6 in Portland, OR).

Absence of Local Restrictions on Receipt and Handling of Spent Nuclear Fuel

Another desirable port factor recommended by the U.S. Merchant Marine Academy Workshop is the absence of local regulatory restrictions on receipt and handling of spent nuclear fuel. It is well established that local restrictions on international or interstate commerce are void under the U.S. Constitution, and similar challenges have been rejected by the Federal courts. For example, the Port of Oakland, CA indicated that a citizen’s legislative initiative in 1987 led to a ban on the handling and transport of foreign research reactor spent nuclear fuel through the port. Although Oakland’s ban was invalidated by the Federal District Court, the Port Authority has maintained some control over radioactive shipments through the port through its permitting system (Adams, 1993). Nevertheless, although claiming to be a “nuclear free zone,” the port continues to allow permitted shipments of certain radioactive materials, handling approximately 500 metric tons (551 tons) of radioactive shipments between January and June 1994 (Adams, 1994).

Further, if DOE were to avoid selection of ports with restrictions by local ordinances, every port wishing to close its doors to receipt of spent nuclear fuel (or any other type of cargo) would simply promulgate an ordinance. Therefore, the EIS will only identify existing local restrictions (formal or informal) in section D.2 for consideration by decisionmakers, and this criterion will have no immediate impact on determination of the acceptability of ports within this EIS.

Secure Short-Term Storage

Although the National Defense Authorization Act requires, to the extent practicable, expeditious movement of casks from a port, the presence of regular guards, fences, and lighted areas that provide security at all times is a desirable attribute. Such additional features provide assurance of safe segregation and short-term storage of foreign research reactor spent nuclear fuel shipments away from workers and the public in the event of unexpected local occurrences, such as snow or ice storms, traffic congestion, and other events beyond the control of spent nuclear fuel shippers.

To best comply with this attribute, the storage area should be one designated for the storage of hazardous materials (referred to as a facility of particular hazard). Such designations are normally simple processes which result in U.S. Coast Guard approval following a request by the terminal operator. While all the military ports are designated as “facilities of particular hazard,” some commercial facilities may only request periodic designations for specific incoming or outgoing cargoes (e.g., the Port of Tacoma, WA periodically designates Terminal 7B for occasional shipments of potentially explosive ammonium nitrate). Table D-7 shows which commercial ports have traditionally had secure storage areas for hazardous cargoes, and DOE has assumed such storage would be available in the future for receipt and short term storage of foreign research reactor spent nuclear fuel. (More detailed information on “facilities of particular hazard” may be found in section D.4.3).

D.1.10 Application of the Desirable Port Attributes in Port Selection

As a result of the evaluation of desirable attributes, two additional ports, Fernandina Beach, FL, and Gulfport, MS, were removed from the potential ports of entry list (Table D-7). The port of Fernandina Beach, FL, is not well-separated from the urban population surrounding the port, and the population is expected to substantially grow by about 82 percent by the year 2010 (see Attachment D2). Also, entry to the port requires ship passage through a State sea manatee (an endangered species) preserve. The Port of Gulfport, MS, does not currently have a well-secured area designated for the storage of foreign research reactor spent nuclear fuel, and it is unlikely it ever will due to casino operations. There is a former cruise ship terminal at the East Pier, which is slated for new casino development, a floating casino located in the port and two new casinos on the West Pier. In addition, the port is not well-separated from surrounding urban population.

Conclusion

As a result of the evaluation, ten ports remained as the final list of ports acceptable for the potential receipt, handling, and transshipment of foreign research reactor spent nuclear fuel. These ten ports [Charleston, SC; Galveston, TX; Hampton Roads (includes terminals in Newport News, Norfolk, and Portsmouth), VA; Jacksonville, FL; MOTSU, NC; NWS Concord, CA; Portland, OR; Savannah, GA; Tacoma, WA, and Wilmington, NC] represent the final list of ports considered for the receipt of foreign research reactor spent nuclear fuel.

D.2 Detailed Information on Potential Ports of Entry

This section of Appendix D provides detailed information that served as the bases for identifying the candidate ports addressed in Section D.1. For convenience, the port details are divided into two categories: (1) the DOE candidate ports of entry that met the criteria developed for port identification in Section D.1, and (2) the remainder of the ports that fully or marginally satisfied the first criterion for appropriate port experience. Within each of the categories, the ports are arranged in alphabetical order. The location of the ports is shown in Figure D-1.

Table D-7 Use of Desirable Attributes for Selecting Final “Low Population” Ports for Foreign Research Reactor Spent Nuclear Fuel Shipments

<i>Ports-of-Entry</i>	<i>Free of Conflicting Uses at Port Facilities</i>	<i>Emergency Preparedness</i>	<i>Short-Term Secure Storage</i>	<i>Free of Environmental Concerns</i>	<i>Free of Severe Natural Phenomena</i>	<i>Terminal Well-Separated from High Density Populations</i>
Commercial						
<i>East Coast</i>						
Charleston, SC	Yes (Wando)	Yes	Yes	Yes	E, H	Yes (Wando)
Fernandina Beach, FL	T	Yes	No	Some (Manatee)	H	No
Hampton Roads, VA	Yes	Yes	Yes ^b	Yes	Yes	Yes (Newport News, VA)
Jacksonville, FL	Yes (Blount Island)	Yes	Yes	Yes	H	Yes (Blount Island)
Savannah, GA	P	Yes	Yes ^b	Yes	E, H	Yes (Container Port)
Wilmington, NC	P, Some Ex ^a	Yes	Yes ^b	Yes	H	Yes
<i>Gulf Coast</i>						
Galveston, TX	Some P, T, Ex ^a	Yes	Yes ^b	Yes	H	No
Gulfport, MS	T ^c	Yes	No	Yes	H	No
<i>West Coast</i>						
Portland, OR	Yes	Yes	Yes ^b	Yes	E, V	Yes (T6)
Tacoma, WA	Yes, some Ex ^a	Yes	Yes	Yes	E, V	Yes
Military						
MOTSU (NC)	Ex ^a	Yes	Yes	Yes	H	Yes
NWS Concord (CA)	Ex ^a	Yes	Yes	Some (wetlands and Tule elk)	E	Yes

Ex= explosives, T = tourism, P = petroleum handling/storage facilities, H = hurricanes/tropical storms,

V = volcanoes, E = earthquakes

^aSeparation of piers and scheduling of spent nuclear fuel and explosive shipments on different days makes consideration of these ports appropriate

^bNo currently designated facilities of particular hazard at preferred terminal(s)

^cExtensive casino development within 1,000 feet

D.2.1 Detailed Information on Candidate Ports of Entry

D.2.1.1 Charleston, SC (Includes the Naval Weapons Station Terminal and the Wando Terminal)

Charleston is the largest port city in South Carolina, and the greater Charleston area is one of the major seaports on the East Coast of the United States. The city of Charleston itself is located at the confluence of the Cooper and Ashley Rivers, approximately 11 km (7 mi) from the entrance from the sea. The principal wharves are along the west bank of the Cooper River except for the Wando Terminal which is along the east bank of the Wando River near Mount Pleasant, about 20 km (11 mi) from the Atlantic Ocean. The city is the center of a rich agricultural district for which it is the distribution point. The entrance to the harbor is maintained by a Federal project providing a channel depth of 10.7 m (35 ft) over the bar, through the entrance and into the major reaches of the Cooper River. The harbor is easy to access in day or night in clear weather, and is one of the best harbors of refuge on the South Atlantic coast (DOC, 1993d). The maps of the port are shown in Figures D-19 (Naval Weapons Station, Charleston) and D-20 (Wando Terminal).

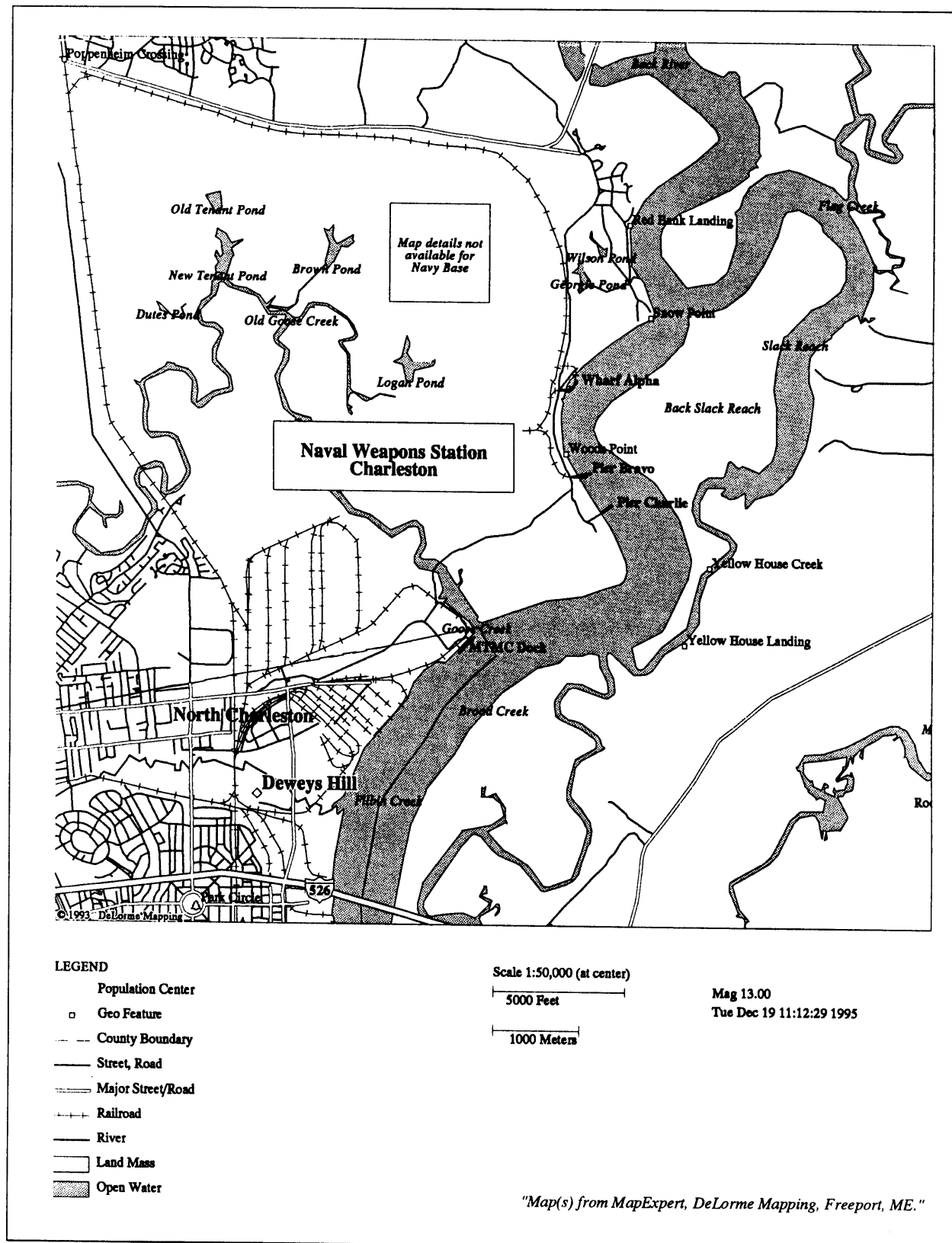
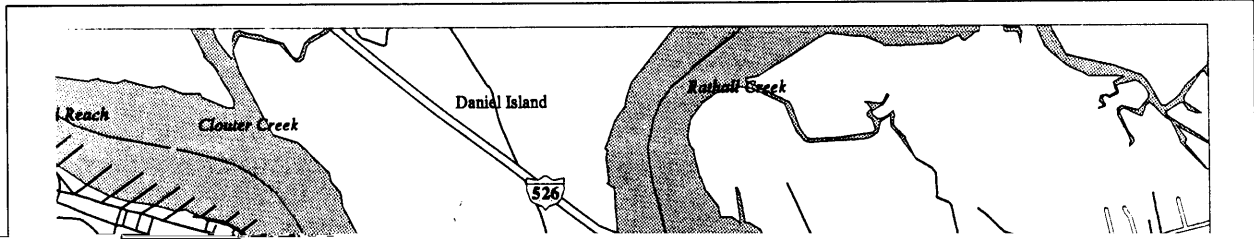


Figure D-19 Map of the Naval Weapons Station, Charleston, SC

SELECTION AND EVALUATION OF POTENTIAL PORTS OF ENTRY



However, the areas to the east and southeast of the port entrance are used extensively by the U.S. Navy and other military services for training exercises which may result in occasional restrictions. Under unfavorable weather conditions current velocities in some areas have been reported as high as 2.1 meters-per-sec (4 knots) (DOC, 1993d). All of the port terminals have 12.2 m (40 ft) of water alongside at mean low water. The port is serviced by many of the world's largest container shipping lines (a total of 56), that handled 807,106 standard 20-ft container equivalents in 1991 (AAPA, 1993; FHI, 1993a). These lines provide service between Europe, the Far East, Japan, Australia and other countries (Jane's, 1992).

The South Carolina State Ports Authority owns and operates four large general cargo and container terminals within the greater Charleston area. The City of Charleston hosts two facilities (Union Pier Terminal and Columbus Street Intermodal Terminal) that were eliminated from consideration because they are not well separated from dense urban populations, and are within the city limits and subject to potential restrictions on receipt and handling of spent nuclear fuel (Jane's, 1992; AAPA, 1993).

The North Charleston Terminal is a container terminal located about 16 km (10 mi) upstream from the city of Charleston. This facility was considered to be inferior to the Wando Terminal because it requires additional transport up a heavily trafficked and more confining channel (only about 120 m (or 400 ft) wide in many reaches) on the upper Cooper River, with ships required to pass below an additional bridge (I-526) over the river (in comparison to Wando Terminal). Further, superior facilities and better separation from populated areas are found at the Wando Terminal discussed below.

In the Draft version of this EIS, only the Wando Terminal was addressed in detail. Public commentators from the Charleston area and other candidate port areas suggested that DOE further consider military ports. Since the Draft EIS was published, the Record of Decision for the SNF&INEL Final EIS (DOE, 1995) directs all aluminum-based spent nuclear fuel to the Savannah River Site. Because of the public requests and the relative proximity of the Savannah River Site to the greater Charleston area, the NWS Charleston has been added as a candidate port of entry, and detailed information is provided in the following section.

Other Pertinent Information: The City of Charleston has a city ordinance restricting the transport of spent nuclear fuel through the city. According to information gathered, the ordinance does not preclude shipment, but requires a permit and approval from the city. The Sandia National Laboratories Radioactive Materials Postnotification Database indicates that the port has not received any spent nuclear fuel since the database was initiated in October 1984 (SNL, 1994), and the NRC has no record of foreign research reactor spent nuclear fuel shipments since 1979, when NRC began approving spent nuclear fuel shipments (NRC, 1993). From discussions with senior port officials, it was determined that Wando Terminal would handle spent nuclear fuel shipments provided they had the approval of the U.S. Coast Guard Captain of the port and the Charleston Fire Department (Moise et al., 1993). Use of City terminals, rather than the Wando Terminal, has the potential for delays in the receipt and transshipment of foreign research reactor spent nuclear fuel, which could result in failing to move the foreign research reactor spent nuclear fuel from the port of entry to the management site "expeditiously." The NWS Charleston is capable of handling spent nuclear fuel shipments provided that the NWS Charleston receives appropriate program "Waivers". A program waiver would have to be issued by the Chief of Naval Operations to allow NWS Charleston facilities to be used to handle spent nuclear fuel shipments. Event waivers would have to be issued by the NWS Charleston Commanding Officer to allow each shipment to be handled. Event waivers are routine procedures used by the NWS Charleston Commanding Officer to place restrictions on conflicting activities, such as ammunition handling (Stark, 1995).

The South Carolina State Ports Authority Port Police are part of an emergency response team comprised of the local fire departments, Coast Guard, and private hazardous materials response organizations. The Ports Authority provides operating personnel basic hazardous materials training. Dock workers are trained in hazardous materials placard recognition and other basic information by the port's stevedores. Security is provided by perimeter fencing with controlled access and the South Carolina State Ports Authority Police Force, which maintains 24-hour manned access booths, patrols, and surveillance. All container terminals have secure open and/or covered storage areas for temporary storage of spent nuclear fuel if

necessary (Moise et al., 1993).

The Wando Terminal is located several kilometers northeast of downtown Charleston in a relatively low population area with good access to interstate highways. Aside from general environmental concern for the wetlands around the port, there are no known special sanctuaries or habitats of concern although the port is subject to severe hurricanes (with high water) and tropical storms. It was the site of the largest earthquake (Modified Mercalli Intensity X) in the Eastern United States in recorded history, on August 31, 1886 (Bolt, 1978). The likelihood of severe natural phenomena such as high winds and earthquakes is reflected in the structural requirements for buildings in each area of the United States. These are shown in the Uniform Building Code (UBC, 1991). For the Port of Charleston, the Uniform Building Code requires buildings to withstand wind speeds up to 160 km/hr (100 mph). The port is located in a moderate seismic zone with an acceleration of 0.15 g.

There are several tanker terminals and petroleum storage depots along the west bank of the Cooper River downstream of the North Charleston Container Terminal (which is also immediately adjacent the Naval Weapons Station off Goose Creek). However, there do not appear to be any conflicting cargoes or activities at the Wando, Columbus, or Union Pier Terminals. The port officials contacted indicated that they believe that radioactive shipments have been made through the port in the past, but they were not sure if spent nuclear fuel had been handled (Moise et al., 1993).

Environmental Conditions

The State of South Carolina has given the lower portion of the Wando River two different water quality classifications. The water is classified as SFH or SA. SFH waters are shellfish harvesting waters and SA waters are suitable for primary and secondary recreation and for other water uses requiring lower quality. According to the U.S. Fish and Wildlife Service's Ecological Inventory Map for James Island, SC, the Wando Terminal and the NWS Charleston are located in a mid salinity estuarine habitat (generally 5 to

In addition, the U.S. Fish and Wildlife Service reports that several protected marine species are known to occur in Charleston County (Banks, 1994). These are the west indian manatee (endangered), Kemp's ridley sea turtle (endangered), leatherback sea turtle (endangered), loggerhead sea turtle (threatened), and the green sea turtle (threatened). Protected bird species include the arctic peregrine falcon (threatened), bald eagle (endangered), wood stork (endangered), red-cockaded woodpecker (endangered), and the piping plover (threatened).

In recent years, two pairs of bald eagles (*Haliaeetus leucocephalus*) nested on the NWS Charleston. One nest was located north of Foster Creek near the POMFLANT storage and activity area, over four miles north of Wharf Alpha. The other was located on the golf course west of Pier X. Their nest tree was destroyed by Hurricane Hugo and the pair have relocated to Big Island, located north of Foster Creek (Department of the Navy, 1994).

Prior to Hurricane Hugo, 12 colonies of red-cockaded woodpeckers, *Picoides borealis*, were known at the NWS Charleston. The red-cockaded woodpecker requires mature pines old enough to be susceptible to red heart disease, which makes the wood soft enough for these small woodpeckers to create a cavity. Such trees are generally at least 70 to 75 years old. Nearly all trees this age were destroyed by Hurricane Hugo, so it is unlikely that the colony could reestablish at this site in the near future (Department of the Navy, 1994).

Wetlands are plentiful on and adjacent to the NWS Charleston. Three basic habitat types found within the area's wetland ecosystem are forested wetlands, nonforested wetlands, and open water. The station's wetland habitats had previously been identified according to the National Wetland Inventory classification system. Within this classification system, the station's wetlands had been placed in four major categories: estuarine, palustrine, lacustrine, and riverine. Based upon that classification, the station contained 1,356 acres of estuarine, 1,730 acres of palustrine and 131 acres of lacustrine wetlands (Department of the Navy, 1994). Field investigations have been performed at the NWS, and no rare or endangered plants or animals were observed (Department of the Navy, 1990 and 1994).

Wetlands at the station contain potential habitat for the flatwoods salamander (*Ambystoma cingulatum*), which is pending placement on the threatened or endangered species list. However, two spot checks of the area by the NWS Charleston environmental personnel have failed to locate either adults or larvae. It has been indicated that a detailed study may be performed of the area in the future (Department of the Navy, 1994).

Climatic Conditions

In general, the elevation of the area ranges from sea level to approximately 6 m (20 ft) on the peninsula. The climate of this region is temperate, primarily due to its close proximity to the Atlantic Ocean. The prevailing winds are generally northerly in the fall and winter months, becoming more southerly during the summer months. This type circulation serves to "warm" the region during winter and "cool" it during the summer. Summer is the rainy season in Charleston, with the city receiving 41 percent of the annual total rainfall during these months. Except for the occasional tropical storm or hurricane, the majority of this rain occurs during afternoon and evening thunderstorms. The late summer and early fall brings the highest probability of tropical storm activity to the Charleston, SC area. The fall season is a transitional period, where temperature extremes are rare and sunshine is abundant. The winters in this area are mild with periods of rain. However, in contrast to the summer, the winter rains tend to be steady and uniform, and last for several days. The most unstable period in this region is spring when the confluence of warm moist

tropical air and cool dry continental air increase the occurrence of severe weather in this region. The average earliest freeze in this area is in early December and the average last frost is in late February (NOAA, 1992c).

D.2.1.1.1 Naval Weapons Station - Charleston

The NWS Charleston is located on the west bank of the Cooper River, north of the city of North Charleston in southeastern Berkeley County, South Carolina. The station occupies about 7080 hectares (17,500 acres) along a 14-km (9-mi) stretch of the Cooper River, starting about 30 km (19 mi) from the Atlantic Ocean. The primary missions of the NWS Charleston are to provide material support for assigned weapons and weapon systems, to provide housing and community support facilities for personnel assigned to the Charleston area, and to do additional tasks such as home porting and logistics support for ammunition ships, and other fleet and shore activities dealing with weapons. Major tenant activities on the station include the new Army Strategic Mobility Logistics Base, a Propulsion Training Facility and the Military Traffic Management Command, an Army organization (Department of the Navy, 1990 and 1994). The Army Strategic Mobility Logistics Base is being constructed on the formerly Polaris Missile Facility Atlantic site (Lewis, 1995).

In selecting a port this far from the open ocean, DOE considered the navigation safety through the

A P P E N D I X D

Wharf Alpha is currently being used to service and load U.S. Navy ammunition ships. With the construction of the Army Strategic Mobility Logistics Base, the Army plans to upgrade in 1998 the rail lines serving Wharf Alpha as well as expanding the wharf itself. The wharf has a mobile crane, and is

able to handle rail cars, receiving that either towed or being able to drive directly onto the wharf load

301 km (188 mi); Oak Ridge Reservation, 644 km (402 mi); Idaho National Engineering Laboratory, 3,910 km (2,441 mi); Hanford Site, 4,580 km (2,858 mi); and Nevada Test Site, 3,930 km (2,543 mi). Distances along rail routes are slightly longer.

D.2.1.1.2 Wando Terminal

The South Carolina State Port Authority Wando Terminal is an ultra modern marine facility that is the designated hazardous materials terminal for the port ("Facility of Particular Hazard"), and is a superior terminal for receipt of spent nuclear fuel. In addition to being outside the city limits of Charleston and not subject to any potential restrictions on receipt and handling of spent nuclear fuel, it is closest to the Atlantic Ocean, and has outstanding facilities. The terminal has 3 container berths and 67.7 ha (167 acres) of paved container storage yard. It has a 428 m (1,400 ft) by 427 m (1,400 ft) turning basin. It currently has 740 m (2,430 ft) of lineal berthing space, but a fourth berth and 35.2 ha (87 acres) of additional paved storage area is currently under construction. The terminal is 8.1 km (5 mi) from the Mark Clark Expressway (I-526), which by-passes most of the city of Charleston and joins Interstate 26 at North Charleston. Of the four terminals in the Port of Charleston, Wando is the only one without direct rail service, requiring trucking of containers about 15 km (9 mi) to intermodal rail yards serviced by the CSX and Norfolk Southern Railroads. This was not considered a serious problem, since most shipments are anticipated to be carried overland by trucks.

The 1990 population within 16 km (10 mi) of the Wando Terminal was 233,434. The affected populations within 0.8 km (0.5 mi) of the interstate routes to the five potential DOE management sites are: Savannah River Site, 65,700; Oak Ridge Reservation, 127,000; Idaho National Engineering Laboratory, 518,000; Hanford Site, 569,000; and Nevada Test Site, 559,000. Populations along rail routes to these sites are slightly larger. The distances to the five potential sites on interstate routes are: Savannah River Site, 325 km (203 mi); Oak Ridge Reservation, 668 km (417 mi); Idaho National Engineering Laboratory, 3,935 km (2,456 mi); Hanford Site, 4,600 km (2,873 mi); and Nevada Test Site, 4,098 km (2,558 mi). Distances along rail routes are slightly longer.

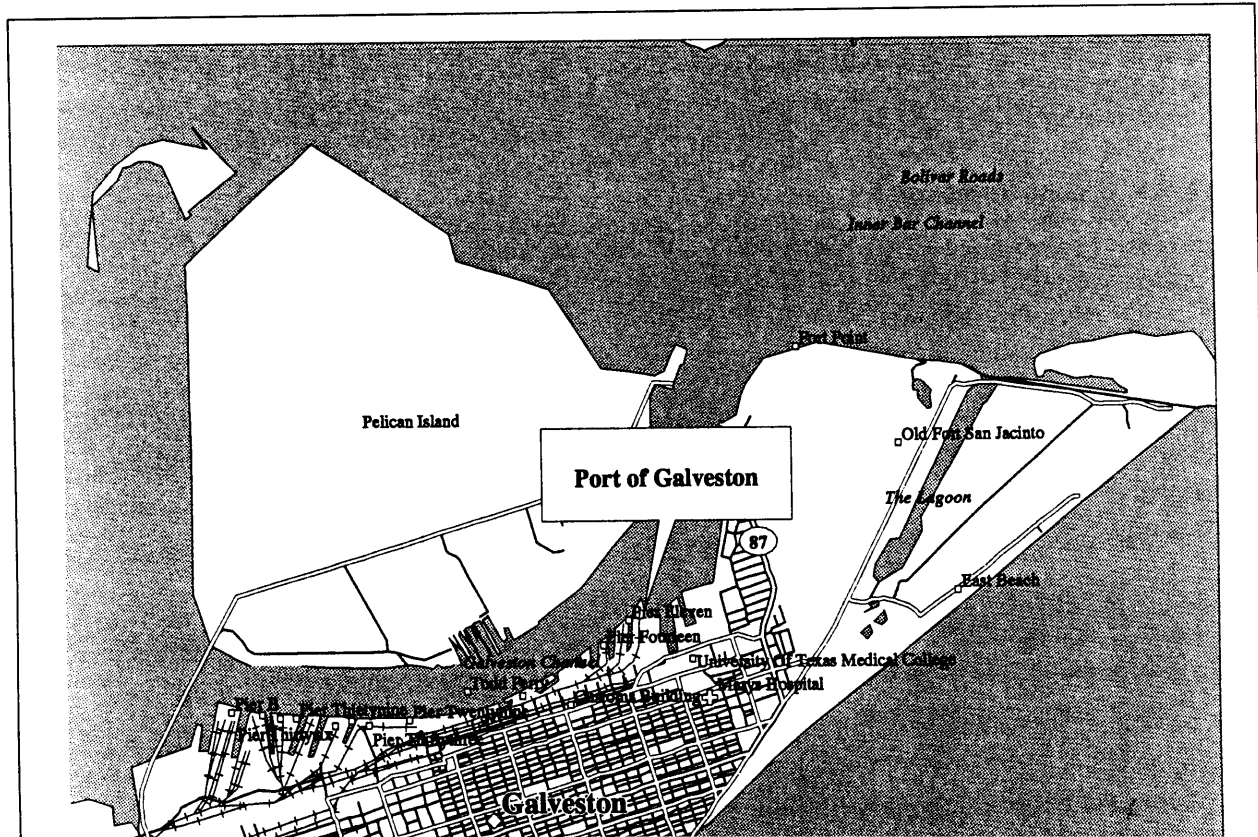
D.2.1.2 Galveston, TX

The Port of Galveston is about 16 km (10 mi) from the Gulf of Mexico via the Galveston channel. The City of Galveston, TX, occupies the entire width of the east end of Galveston Island. The shipping wharves are on the north side of the island and the Gulf of Mexico is on the south. The Port of Galveston is located in the heart of the City (DOC, 1992a). A map of the port is shown in Figure D-21.

As stated in the Coast Pilot, the Port of Galveston offers a short route to the sea and, together with the deep and easily navigated channel and excellent port facilities, enables Galveston to handle cargo most expeditiously and economically (DOC, 1992a). A Federal project provides for an entrance channel and an outer bar channel both dredged to 12.8 m (42 ft), thence 12.2 m (40 ft) to Galveston. The Port of Galveston is a multi-terminal port complex located on the northeastern end of Galveston Island, only 15 km (9.3 mi) from the entrance buoy to the open sea. Overall tonnage reported for 1991 was 4,159,233 metric tons (4,584,723 tons), of which approximately 17 percent (703,511 metric tons or 773,862 tons) was containerized freight (over 70,000 20-ft equivalent units). Roughly 77 percent of the tonnage was dry and liquid bulk, much of it grain (AAPA, 1993).

The Port of Galveston is a separate utility of the City of Galveston with its powers established by the City Charter. The Charter provides that all city-owned wharf and terminal properties be set aside and controlled, maintained, and operated by a "Board of Trustees of the Galveston Wharves."

APPENDIX D



Principal container lines and the areas they serve include: Lykes Brothers — North Europe, Mediterranean, Mexico and West Coast of South America; Deppe Line — North Europe; Companhia Maritima Nacional — Brazil/Mexico; Compania Chilean Navegacion Interoceanica — South America/Mexico, and Del Monte/Network Shipping — Guatemala/Mexico (Jane's, 1992; AAPA, 1993).

Pier 10 Container Terminal: This is Galveston's principal container handling facility. It is owned by a

private operator, Container Terminal of Galveston, Inc., who operates the facility as a public terminal. This facility has two berths, four container cranes, and 19.83 ha (49 acres) of paved storage area. The Port of Galveston owns an additional ten (10) open-dock ship berths and 20 berths with shipside warehouses used for breakbulk and other cargoes. The Container Terminal of Galveston, Inc. has two berths with a total length of 410 m (1,346 ft). Depth alongside the Container Terminal of Galveston, Inc. at mean low water is 12.2 m (40 ft). Crane capacities on Container Terminal of Galveston, Inc.'s Pier 10 are three 50.8 metric tons (56 ton) container cranes and one 61.0 metric tons (67 ton) container crane. All cranes are equipped with 40.6 metric tons (45 ton) capacity spreaders.

The Container Terminal of Galveston, Inc. has a controlled all-weather truck entrance and interchange area. The terminal is connected to Interstate Highway 45 on the mainland by the 9.3 km (5.8 mi), four-lane State Highway 87 and two 2.8 km (1.75 mi) causeways that cross the southwest end of Galveston Bay. The island portion of the limited access route is through densely populated built-up areas. The Container Terminal of Galveston, Inc. is served by four major railroads: the Burlington Northern, Santa Fe, Southern Pacific, and Union Pacific Lines. Galveston Railway, Inc., provides terminal connections and performs switching of all rail traffic. An intermodal container transfer terminal is located within the container terminal and trackage extends to within 30.5 m (100 ft) of ship berths (Jane's, 1992; AAPA, 1993; Schultz, 1993).

Other Pertinent Information: The Port of Galveston has its own security force that provides 24-hour surveillance of its terminals. Container Terminal of Galveston, Inc. is fenced and has controlled access. An area is provided for segregation and temporary storage of hazardous cargoes.

The Port of Galveston's Director of Operations was unaware of any regulations prohibiting the importation of spent nuclear fuel (Schultz, 1993). The port occasionally handles hazardous materials, including Class A explosives (Schultz, 1993). NRC records indicate the port has not handled foreign research reactor spent nuclear fuel since at least 1979 (NRC, 1993).

The container terminal operator is responsible for handling hazardous materials emergencies at the Container Terminal of Galveston, Inc. facility. The Port of Galveston relies on the Galveston Fire Department's hazardous materials team and/or highly trained hazardous materials personnel at refineries located some 16-24 km (10-15 mi) away. The West Gulf Employers Association holds training courses for longshoremen which Port of Galveston terminal personnel also attend (Schultz, 1993).

(IPA, 1993). The U.S. Coast Guard accident data for the period 1991-1993 indicate 52 reported accidents in the Galveston Bay area (USCG, 1994b). This includes ship traffic bound for the Houston area and also includes barge accident data.

Other than general heightened environmental awareness, there are no known sensitive environmental areas in the Port of Galveston area (Schultz, 1993). The port is subject to hurricane and tropical storms. The likelihood of severe natural phenomena such as high winds and earthquakes is reflected in the structural requirements for buildings in each area of the United States. These are shown in the Uniform Building Code (UBC, 1991). For the Port of Galveston, the Uniform Building Code requires buildings to withstand wind speeds up to 160 km/hr (100 mph). The port is located in a very low seismic zone with an acceleration of less than 0.075 g.

The 1990 census population within 16 km (10 mi) of the port terminals was 73,322. The affected populations within 0.8 km (0.5 mi) of the interstate routes to the five potential DOE management sites are: Savannah River Site, 403,000; Oak Ridge Reservation, 337,000; Idaho National Engineering Laboratory, 526,000; Hanford Site, 575,000; and Nevada Test Site, 595,000. Populations along rail routes to these sites are slightly larger for Savannah River Site and Oak Ridge Reservation, but are slightly less for Idaho National Engineering Laboratory, Hanford Site, and Nevada Test Site. These populations are shown in Figures D-8 through D-17 in Section D.1. The distances to the five potential sites on interstate routes are: Savannah River Site, 1,600 km (1,000 mi); Oak Ridge Reservation, 1,550 km (963 mi); Idaho National Engineering Laboratory, 3,070 km (1,911 mi); Hanford Site, 3,740 km (2,327 mi); and Nevada Test Site, 3,000 km (1,862 mi). Distances along rail routes are slightly longer.

Environmental Conditions

A large number of aquatic and terrestrial species frequent the Galveston Bay area. A variety of birds migrate, winter, and breed along the Texas Coast including shorebirds, songbirds, waterfowl, and raptors (Breslin, 1993; FWS, 1992). These endangered/threatened bird species include the brown pelican, peregrine falcon, bald eagle, Attwater's greater prairie-chicken, piping plover, and the eskimo curlew (State-threatened only). Endangered/threatened marine mammals and sea turtles also are found in the coastal bay systems and the Gulf of Mexico. Galveston Bay is within the range of the green, hawksbill, Kemp's ridley, leatherback, and loggerhead sea turtles. While no protected species are known to be located within the Port of Galveston, significant populations of the endangered brown pelican and the piping plover exist nearby (Werner, 1994). The U.S. Fish and Wildlife Service reported that as many as 600 brown pelicans have been sighted loafing on the north end of Little Pelican Island, which is approximately 5.6 km (3.5 mi) northwest of the port. In addition, approximately 125 pairs nested and produced 90 young for the year at this site in 1994, the first time that brown pelicans had successfully nested in Galveston Bay in over 40 years. Wintering populations of the threatened piping plover use the

While the port area is highly developed, a wide variety of marine, estuarine, and lacustrine wetlands exist along Galveston Bay, including a large portion of Pelican Island, directly west of the port. Wetlands also occupy the majority of the far northern end of Galveston Island (FWS, n.d.a.).

Climatic Conditions

The City of Galveston is bounded on the southeast by the Gulf of Mexico and on the northwest by Galveston Bay. Thus, the climate of the Galveston area is predominantly marine, with periods of modified continental influence during the colder winter months when cold fronts from the northwest sometimes reach the Texas coast. Because of its coastal location, sub-freezing temperatures are rare, and higher than normal humidities prevail throughout the year. Summer rainfall is highly variable across the island due to thunderstorms and the local sea breeze circulation. Winter precipitation comes mainly from frontal

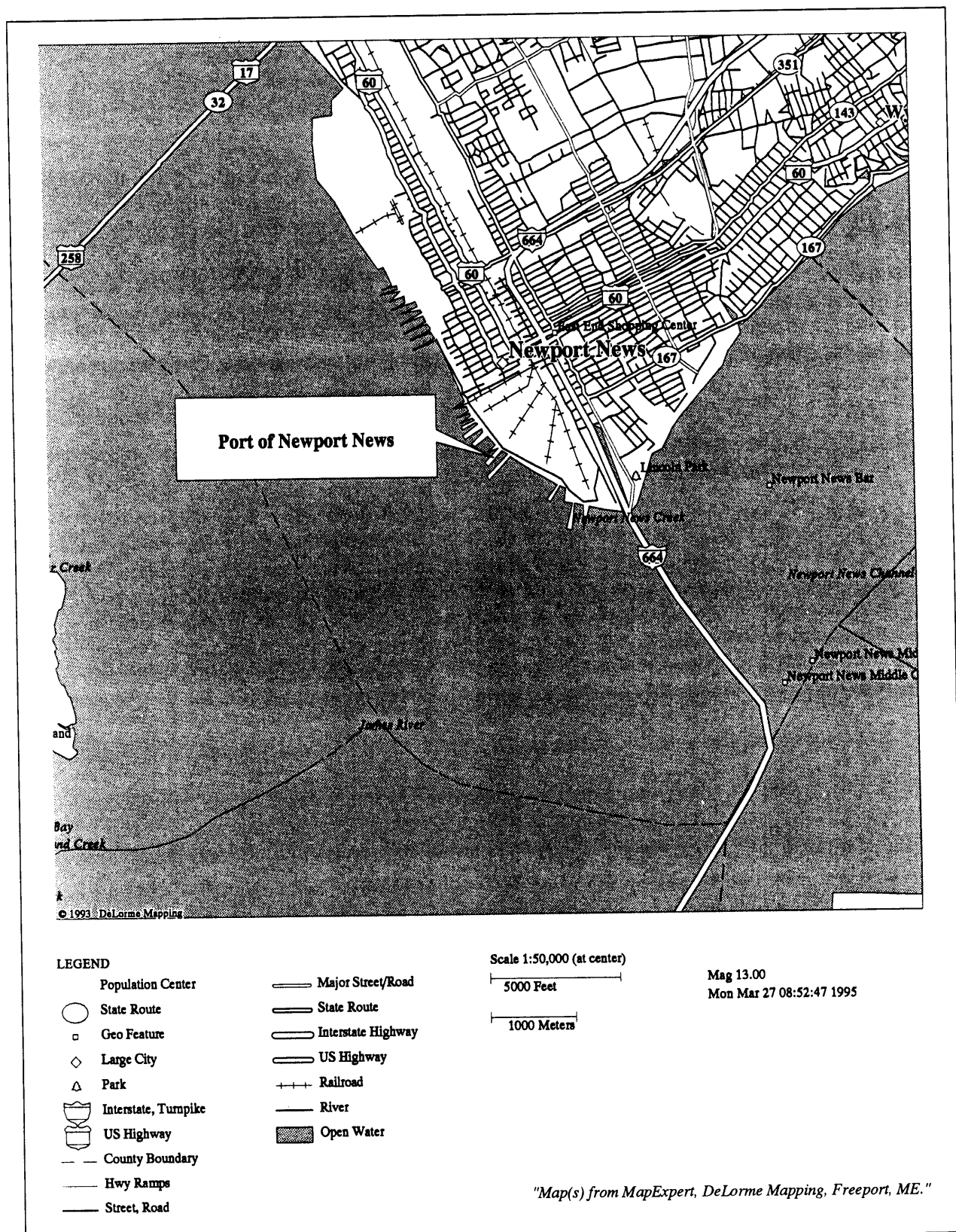
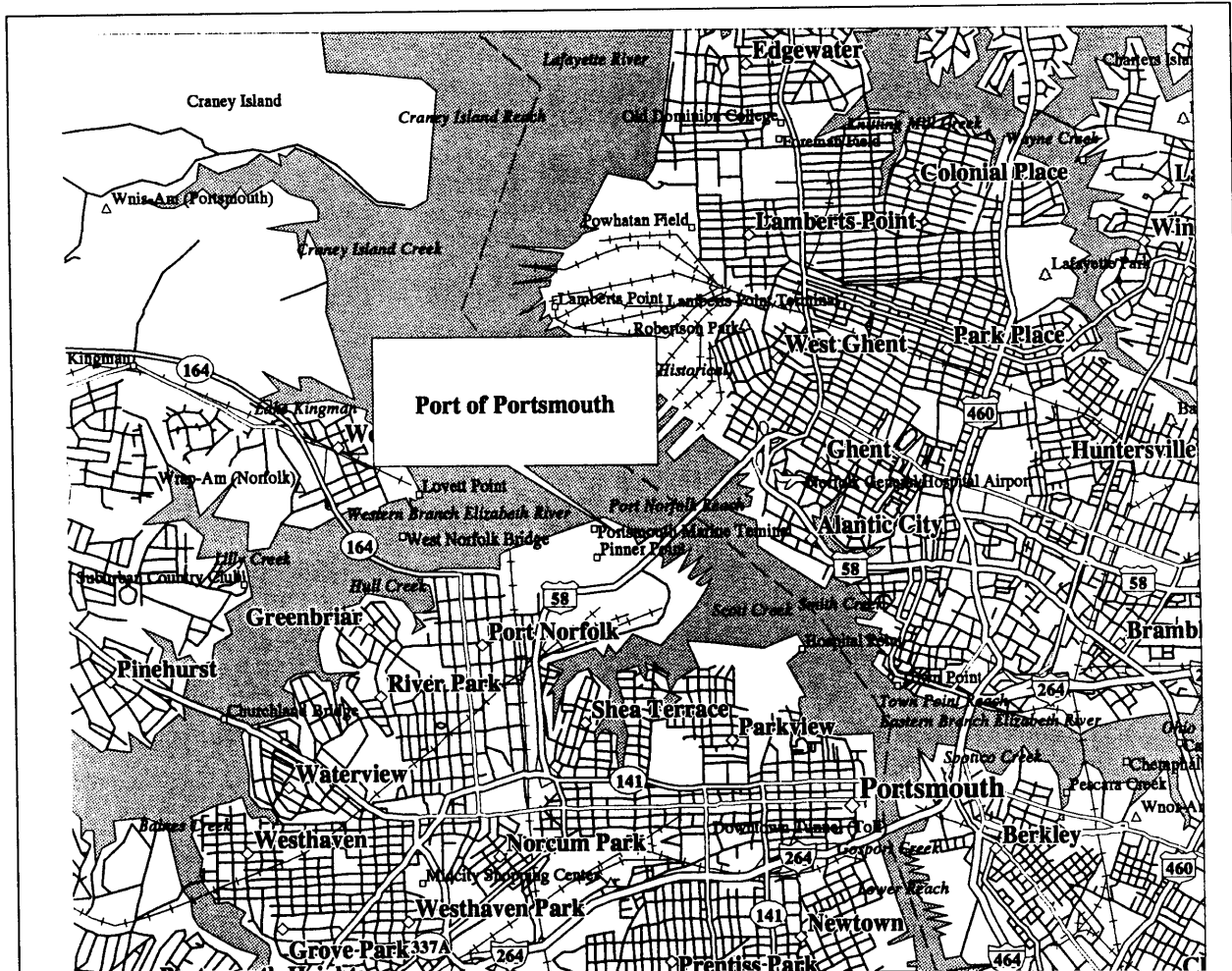


Figure D-22 Map of the Port of Newport News, VA

SELECTION AND EVALUATION OF POTENTIAL PORTS OF ENTRY





Changing weather can also be a concern as noted in the U.S. Coast Pilot: "Weather deterioration in the lower bay is often sudden and violent and constitutes an extreme hazard to vessels operating or anchoring in this area. The proximity of the bridge-tunnel complex to main shipping channels adds to the danger. Currents in excess of 1.5 meters-per-sec (3 knots) can be expected in this area" (DOC, 1993c).

The presence of three major vehicle tunnels (Chesapeake Bay tunnels, and Hampton Roads Tunnel with associated bridges) under the shipping channels are also sources of risk from ship collisions, especially in fog or during bad weather. Overall, however, the transit is direct and well-managed (DOC, 1993c).

The terminals of primary interest are owned by the Virginia Port Authority, that is a state agency reporting to the Secretary of Economic Development. The Virginia Port Authority's three large, general cargo terminals within the Greater Hampton Roads harbor area include Norfolk International Terminals which is a large container port that includes Sewell's Point Docks (a breakbulk facility), Portsmouth Marine Terminal, and Newport News Marine Terminals. These Terminals are operated by the Virginia International Terminals (the operating arm of the Virginia Port Authority). Lambert's Point Docks, a large breakbulk terminal owned by Norfolk Southern Railroad is also located on the Norfolk waterfront, but lacks container cranes. All three terminals are located in commercial port districts of their respective cities, somewhat separated from other community activities, in areas dedicated primarily to port industrial usage. The three Virginia Port Authority terminals are discussed below in subsections by terminal (Jane's, 1992; AAPA, 1993; FHI, 1994b; DOE, 1994d; VPA, 1994).

Other Pertinent Information: There are no regulatory restrictions prohibiting the receipt and handling of spent nuclear fuel in the port. Compliance with hazardous materials regulations (49 CFR) is the primary requirement. The Portsmouth Marine Terminal has had extensive experience in the receipt and handling of spent nuclear fuel shipments in the recent past, and Norfolk International Terminal and Newport News Marine Terminal also have had some experience (SNL, 1994; NRC, 1993). There appears to be little or no conflict with other hazardous cargoes, including petroleum products, naval weapons depots, etc., in the immediate vicinity of the three Virginia Port Authority terminals. The Virginia Port Authority depends on the Hampton Roads Emergency Team for response to hazardous materials accidents within its terminals. Hampton Roads Emergency Team consists of the fire departments of Norfolk, Portsmouth, and Virginia Beach, in liaison with the U.S. Coast Guard. Chief White of the Portsmouth Fire Department is in charge of the team, which also has ties to the State Emergency Team. All of the Virginia Port Authority terminal operating personnel and longshoremen are currently trained in hazardous materials awareness. Security for the port is provided by perimeter fences and the Virginia Port Authority's Port Police, which maintain 24-hour patrol and surveillance at all three terminals. The state of Virginia's Safety Manual sets forth the rules and policies for operations, including, among other things, hazardous cargoes, container control, emergency procedures and general safety, and provides the policy for receipt and handling of radioactive materials, including emergency response, personnel protection, facility protection, environmental protection and cargo protection (Edwards and Drews, 1993).

All three terminals are located in a large urban area in which congestion is to be expected. Of the three terminals, Portsmouth Marine Terminal is located closest to residential and downtown areas; however, Portsmouth is a relatively small city in both area and population, and it is only a short distance from the terminal to more sparsely populated rural areas. Conversely, truck shipments from Norfolk International Terminals, the terminals closest to the sea, must travel about 38 km (24 mi) of heavily trafficked Interstate through built-up sections of Norfolk, Virginia Beach, and Chesapeake before reaching Bowers Hill (a rural area). The comparable distance from Portsmouth is about 6 km (4 mi).

A P P E N D I X D

The likelihood of severe natural phenomena such as high winds and earthquakes is reflected in the structural requirements for buildings in each area of the United States. These are shown in the Uniform

releases (e.g., fires) would be expected to be negligible. In port, any potential negative impacts of low-probability, severe accidents on wildlife populations would be limited to the immediate area around the terminals.

Climatic Conditions

The Port of Hampton Roads, VA is located at the confluence of the James River and the Chesapeake Bay, approximately 29 km (18 mi) west of the Atlantic Ocean. The average elevation of this region is approximately 4 m (13 ft) above sea level.

The geographic location of this region is especially favorable, tending to be located south of the predominant winter extratropical cyclone tracks which originate at higher latitudes and north of the usual

tropical cyclone (e.g., tropical storms and hurricanes) paths. In general, the winters are mild with slightly warmer temperatures during the spring and fall seasons. The summer season is warm and long, but is characterized by frequent cool periods, generated by cool northeasterly winds off of the North Atlantic. Extreme cold waves are infrequent, and temperatures below 18°C (0°F) are almost nonexistent. In

D.2.1.3.2 Norfolk International Terminals

This is the Virginia Port Authority's largest container handling facility, located on the south side of the Port in Norfolk, adjacent to the Navy Base on the Elizabeth River Channel. The Norfolk International Terminals have a wharf area of 328 ha (811 acres), 4 container berths, 7 container cranes, room for stacking 23,930 20-ft equivalent units four high, chassis stackers for 702 chassis, a roll-on/roll-off berth and covered pier storage of 83,640 m² (900,000 ft²) plus associated container terminal handling

On the other side of the river, located at the north end (acquired) of the Norfolk International

The 1990 population within 16 km (10 mi) of the port terminals was 665,700. The affected populations within 0.8 km (0.5 mi) of the interstate routes to the five potential DOE management sites are: Savannah River Site, 135,000; Oak Ridge Reservation, 257,000; Idaho National Engineering Laboratory, 670,000; Hanford Site, 718,000; and Nevada Test Site, 732,000. Populations along rail routes to these sites are about the same for Eastern sites and slightly larger for Western sites. These populations are shown in

Figures D-8 through D-17 in Section D.1. The distances to the five potential sites on interstate routes are: Savannah River Site, 810 km (501 mi); Oak Ridge Reservation, 780 km (487 mi); Idaho National Engineering Laboratory, 4,040 km (2,514 mi); Hanford Site, 4,710 km (2,930 mi); and Nevada Test Site, 4,210 km (2,617 mi). Distances along rail routes are slightly longer.

D.2.1.4 Jacksonville, FL

The Port of Jacksonville is located on the Atlantic Coast of Northern Florida, along the St. Johns River. It is a geographically large city (1,967 km² or 760 mi²), ranging from the town of Orange on the east side of the river to Julington Creek on the west side. Most of the marine terminals are on the west side of the river, about 34 km (21 mi) from the ocean entrance. However, the Blount Island container terminal is well-separated from the city, and is only about 11 km (7 mi) from the harbor entrance. A Federal Project maintains a channel depth of 12.2 m (40 ft) to 12.8 m (42 ft) at the entrance to the river. The depth gradually decreases to about 9.1 m (30 ft) at the railroad bridge in Jacksonville. The Blount Island Terminal is located downstream from the railroad bridge in a deeper part of the channel (DOC, 1993d; Jane's, 1992; AAPA, 1993; Southern Shipper, 1993). A map of the port is shown in Figure D-25.

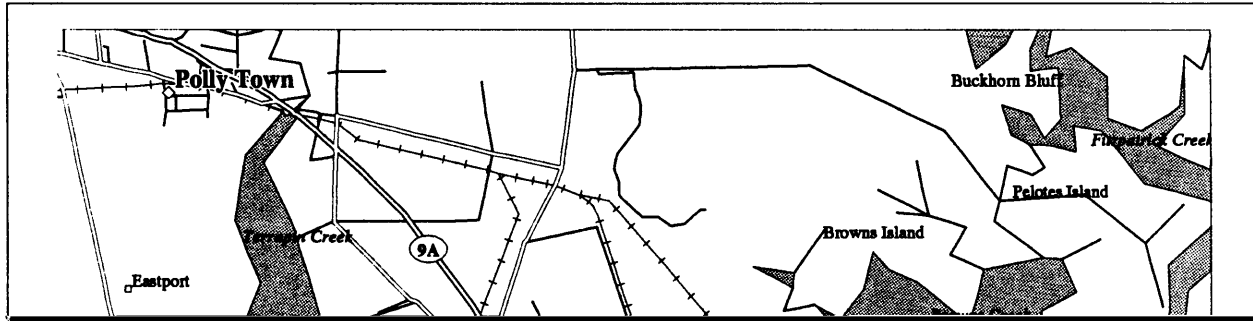
The St. Johns River has a deep, steep-sided channel cut through the rock in some areas. This channel configuration, combined with the increased size and draft of vessels entering the port makes the river difficult to navigate. Tidal currents in the river are strong as far as Jacksonville, approaching 1.5 meters-per-sec (3 knots) in several places (DOC, 1993d).

The Jacksonville Port Authority (Jaxport) operates two deep water container/general cargo terminals: Blount Island, located approximately 11 km (7 mi) from the harbor entrance and Talleyrand Docks and Terminals, located about 34 km (21 mi) from the entrance. Both terminals are equipped with modern entrance cranes, handle breakbulk and other types of cargo, and have transit sheds, warehouses, and open storage areas. Of the two, Blount Island is preferred because of its separation from the high density downtown area and closer proximity to the sea. A new terminal is under consideration adjacent Blount Island at Dames Point (Southern Shipper, 1993).

Both terminals serve a number of major general cargo and container ship lines from around the world including Sea-Land, NYK, Hyundai, and Mitsui OSK, that offer worldwide cargo services, and Columbus and Blue Star Line (Australia service). These lines provide service to many regions of the world, including Europe, the Mideast, South America, and Australia (Southern Shipper, 1993; Jane's, 1992).

Blount Island Terminal: Blount Island is a 356 ha (880 acre) facility with 1,920 m (6,299 ft) of berthing space, of which Berth 12 is the longest [351 m (1,150 ft)]. Blount Island Berths 7-13 have 11.6 m (38 ft) of water alongside at mean low water, and five 40.6 metric ton (45 ton) container cranes. It has 34,000 m² (360,000 ft²) of transit sheds/warehousing and 149 ha (367 acres) of open storage. This terminal is connected to the mainland via a fixed highway bridge that joins State Highway 105 (Necksher Drive) and connects with I-95 and Route 17 about 8 km (5 mi) north of the City of Jacksonville. A new eight lane truck security plaza was dedicated in 1992. Blount Island has pierside service by the CSX Railroad that connects with the Norfolk Southern Railroad (Southern Shipper, 1993).

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Talleyrand Terminal: Talleyrand Docks is a 70 ha (172 acre) facility with 1,250 m (4,100 ft) of marginal wharf on deep water [11.6 m (38 ft)] at mean low water. It has two 40.6 metric ton (45 ton) container cranes, and two large gantry whirley cranes [50.8 metric ton (56 ton) and 102 metric ton (112 ton)], and 14,900 m² (160,000 ft²) of transit sheds/warehousing with 49 ha (120 acres) of paved open storage (fenced and lighted). Talleyrand Terminal is located in downtown Jacksonville's shopping and commercial zone, about 2.9 km (1.8 mi) downstream of the John R. Matthews Bridge (alternate U.S. Route 90), and less than 1 km (0.6 mi) via city streets to the Expressway (alternate U.S. Route 1) (Southern Shipper, 1993).

Other Pertinent Information: The Port Authority is not aware of any local regulatory restrictions on receipt and handling of spent nuclear fuel (Castiel, 1993). The terminals have no prior experience handling spent nuclear fuel (SNL, 1994; NRC, 1993) or hazardous wastes, but do handle hazardous cargoes such as poisons, corrosives, and Class B explosives. Jaxport is a member of Jacksonville Spillage Control and the City of Jacksonville's Hazardous Materials Team. Terminal operating personnel and longshoremen receive basic instruction in the handling of hazardous cargoes. Around the clock security is provided to both terminals by the Jacksonville Port Authority, with secure, short-term storage available if needed.

There are several tanker terminals and petroleum storage depots downstream and immediately adjacent Talleyrand Docks and Terminals. Blount Island Terminal appears to have no petroleum terminals or other conflicting cargo activities (Castiel, 1993).

While the entire State is environmentally aware, there are no known sensitive wildlife sanctuaries in the immediate area of Jaxport. Blount Island is surrounded by extensive marsh and wetlands. The port is subject to severe hurricanes and tropical storms. The likelihood of severe natural phenomena such as high winds and earthquakes is reflected in the structural requirements for buildings in each area of the United States. These are shown in the Uniform Building Code (UBC, 1991). For the Port of Jacksonville, the Uniform Building Code requires buildings to withstand wind speeds up to 160 km/hr (100 mph). The port is located in a very low seismic zone with an acceleration of less than 0.075 g.

The 1990 population within 16 km (10 mi) of the port terminals was 334,212. The affected populations within 0.8 km (0.5 mi) of the interstate routes to the five potential DOE management sites are: Savannah River Site, 46,900; Oak Ridge Reservation, 175,000; Idaho National Engineering Laboratory, 576,000; Hanford Site, 643,000; and Nevada Test Site, 639,000. Populations along rail routes to these sites are slightly larger. These populations are shown in Figures D-8 through D-17 in Section D.1. The distances to the five potential sites on interstate routes are: Savannah River Site, 607 km (377 mi); Oak Ridge Reservation, 912 km (567 mi); Idaho National Engineering Laboratory, 4,030 km (2,504 mi); Hanford Site, 4,700 km (2,924 mi); and Nevada Test Site, 4,190 km (2,607 mi). Distances along rail routes are about the same.

Environmental Conditions

The area between the mouth of the St. Johns River and Blount Island is characteristic of typical coastal lowlands found along the southeastern United States. Numerous creeks meander through large expanses of marshes and swamps. With the exception of the U.S. Naval Station Mayport and the village of Mayport, which occupy the first several kilometers along the southern bank of the river, the land bordering the lower portion of the river is largely undeveloped, with the exception of riverfront residences, mainly along the northern bank. In fact, most of the land to the north of the river between Blount Island and the coast is part of the Nassau River - St. Johns River Marshes Aquatic Preserve. The Fort Caroline National Memorial is located southeast of Blount Island on the southern bank of the river. The Little Talbot Island State Park is located approximately 1.6 km (1 mi) north of the channel entrance.

The lower 24.2 km (15 mi) of the St. Johns River has been designated as critical habitat for the manatee, a listed endangered species. The river is also used as a migratory area for the shortnose sturgeon, a listed endangered species (FWS, 1980e). According to the Florida Natural Areas Inventory, the following rare species have been reported within 3.2 km (2 mi) of the Blount Island Terminal: West Indian Manatee (State and Federal Listed Endangered Species), shortnose sturgeon (State and Federal Listed Endangered Species), Atlantic sturgeon (State Listed Species of Special Concern and Federal Listed Threatened Species), sea lamprey, and the opossum pipefish (Murray, 1994). In addition, the U.S. Fish and Wildlife Service reports that the following protected marine species may occur in Duval County: west indian manatee (endangered), shortnose sturgeon (endangered), Kemp's ridley sea turtle (endangered), leatherback sea turtle (endangered), loggerhead sea turtle (threatened), hawksbill sea turtle (endangered), and the green sea turtle (threatened). Protected bird species include the bald eagle (endangered), wood stork (endangered), piping plover (threatened), and red-cockaded woodpecker (endangered) (Bentzen, 1994).

A variety of wading birds are also found in the vicinity of the Fort Caroline National Memorial. Several species of birds, including shorebirds, waterfowl, and gannets frequent the area around the jetties at the channel entrance. In particular, the brown pelican (a State Species of Special Concern) is found in this area. A variety of birds inhabit the Little Talbot Island State Park, including the American oystercatcher (a State Species of Special Concern). Loggerhead sea turtles (a listed endangered species) use the beaches along this portion of Florida as a nesting area (FWS, 1980e).

Climatic Conditions

The Port of Jacksonville, FL, is located along the lower 39.4 km (24.5 mi) of the St. Johns River. The terrain in this area is relatively level, providing very little change in relief proceeding inland from the coastal region.

As with the other more northern ports, the climate of this area is also modified by the influence of the Atlantic Ocean. Easterly winds occur roughly 40 percent of the time, producing a true maritime climate for the Jacksonville area. The greatest rainfall occurs during summer months, associated with the

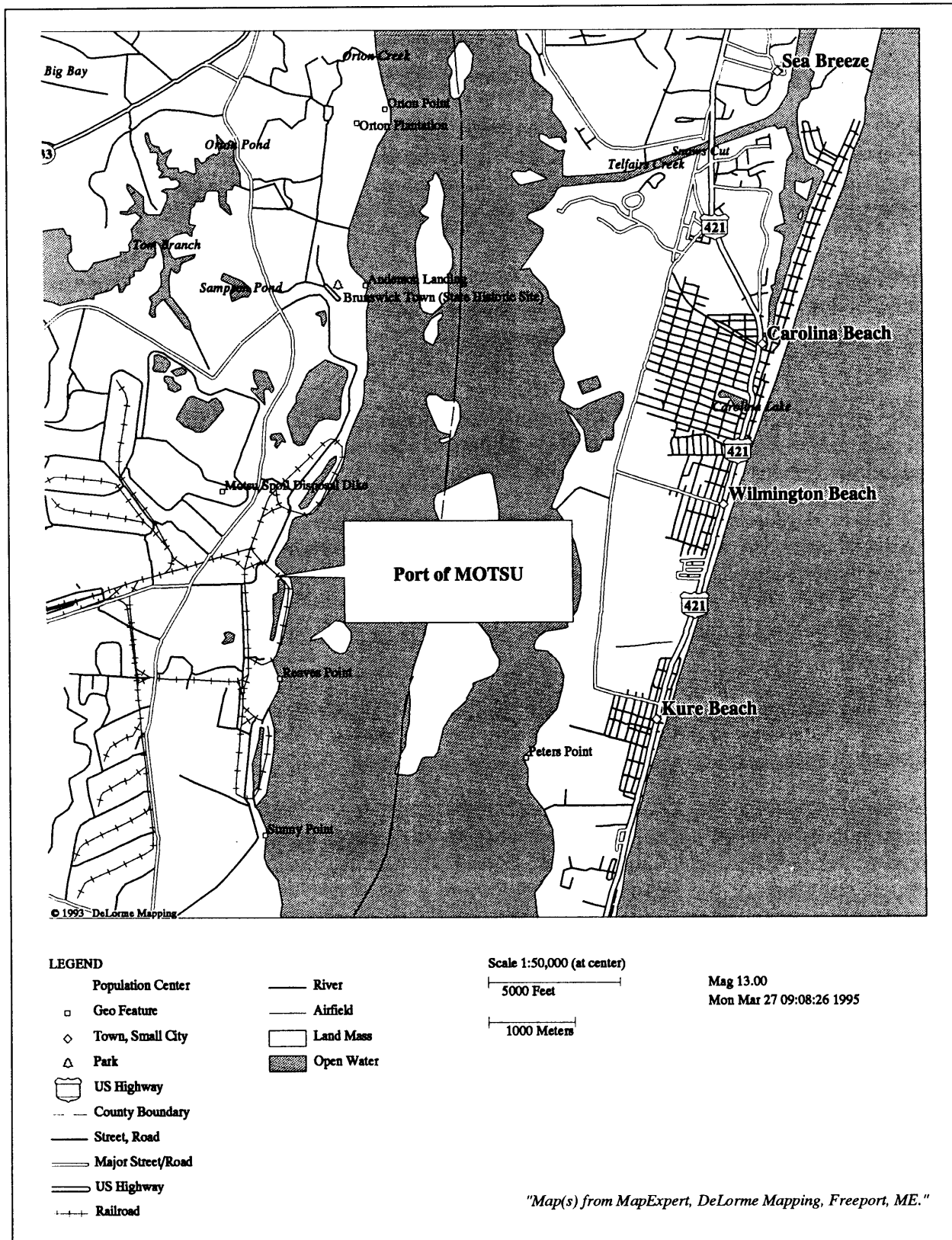


Figure D-26 Map of the Military Ocean Terminal, Sunny Point, NC

Since the majority of cargoes handled at MOTSU are explosive, the terminal is laid out such that an explosion at one wharf will not seriously impact activities at an adjacent wharf. This would permit containerized spent nuclear fuel carried in a commercial vessel (without explosive or hazardous cargoes on-board) to be safely received and transported from the terminal, even though there are conflicting activities within the terminal. Further, after many years of service, MOTSU has never had an explosion accident, so the risks are believed to be small. However, unloading of spent nuclear fuel would be scheduled during periods when explosives were not being unloaded. On average, MOTSU receives about 70 vessels per year, and moves approximately 433,000 metric tons (476,000 tons) of cargo through the port.

While regularly scheduled commercial container or breakbulk vessels do not call at MOTSU, commercial container vessels chartered by defense agencies routinely call at the port. The water depth (channel and alongside the wharves) of 10.3 m (34 ft) mean low water is adequate for most commercial breakbulk, roll-on/roll-off, and container ships. The terminal has three 606 m (2,000 ft) wharves, each with three berths. All wharves have three parallel sets of rail tracks. Berth 1, on the south wharf, has two 45.3 metric ton (50 ton) container cranes capable of off-loading container or container/breakbulk vessels. Berth 3 has been modified with a 30 m (100 ft) wide, reinforced concrete apron that permits breakbulk and roll-on/roll-off operations in addition to containerized cargoes (DOE, 1994d).

MOTSU is serviced by well-maintained roads which are primarily two-lane roads providing connections to multi-lane controlled access highways. In the event that MOTSU was utilized for receipt of foreign research reactor spent nuclear fuel, all transport of spent nuclear fuel over these roadways would be in conformance with State regulations for normal truck traffic between MOTSU and other locations to avoid overloading roadways and bridges. Truck access is provided by State Route 87 from the northwest and State Route 133 from the north. Route 87 provides access to U.S. 17, which runs southwest or northeast. The distance from the terminal gate to Route 133 is about 3.7 km (2.2 mi). Route 133 runs directly to U.S. 17 just outside Wilmington, NC. From Wilmington, U.S. 74 runs west 120 km (75 mi) to Interstate 95, the nearest major north-south highway (DOE, 1994d). A dedicated 157 km (97.4 mi) U.S. Army rail line connects the CSX network directly to the terminal.

Other Pertinent Information: At the present time, there are no regulatory restrictions on receipt, handling, and transshipment of foreign research reactor spent nuclear fuel at MOTSU. MOTSU is the only port in the contiguous United States which has current experience with foreign research reactor spent nuclear fuel receipt and handling, with two shipments received in October 1994 under the Urgent Relief Environmental Assessment.

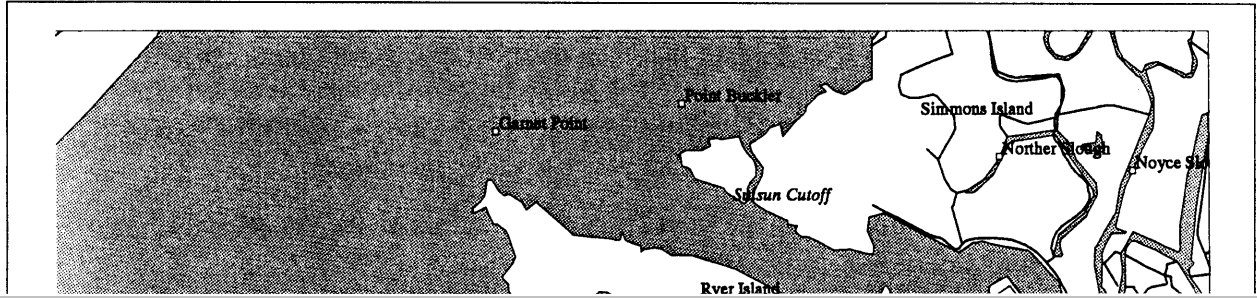
Cargo handling at the terminal, including explosives, is performed by members of the International Longshoremen Association. Port security is maintained on land by security guards, and on water by dedicated patrol boats.

The likelihood of severe natural phenomena, such as high winds and earthquakes, is reflected in the structural requirements for buildings in each area of the United States. These are shown in the Uniform Building Code (UBC, 1991). For MOTSU, the Uniform Building Code requires buildings to withstand wind speeds up to 160 km/hr (100 mph). The port is located in a low seismic zone with an acceleration of 0.075 g.

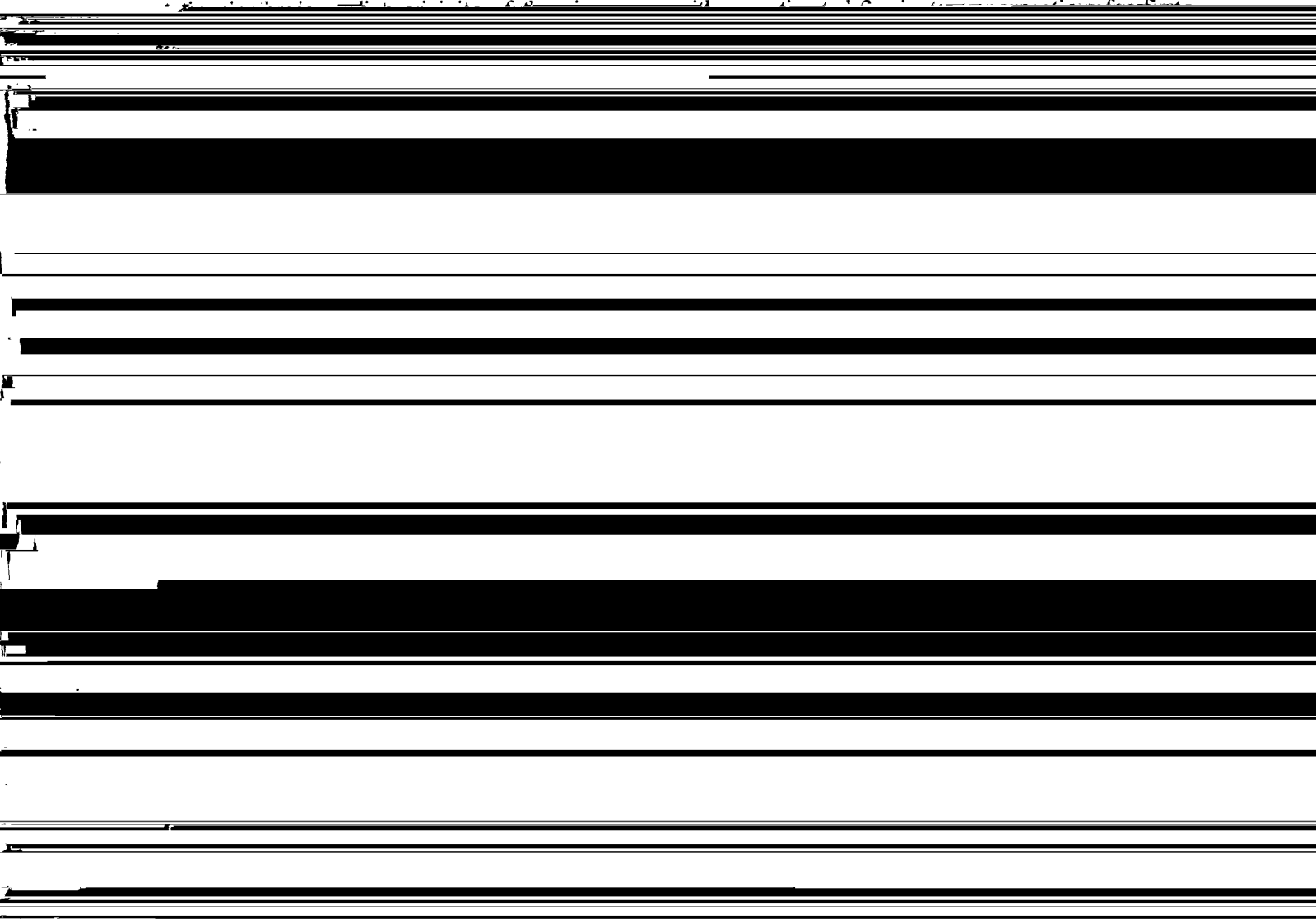
The 1990 population within 16 km (10 mi) of the port terminals was 7,995. The affected populations within 0.8 km (0.5 mi) of the interstate routes to the five potential DOE management sites are: Savannah River Site, 34,200; Oak Ridge Reservation, 128,000; Idaho National Engineering Laboratory, 463,000; Hanford Site, 548,000; and Nevada Test Site, 619,000. Populations along rail routes to these sites are

slightly larger. These populations are shown in Figures D-8 through D-17 in Section D.1. The distances to the five potential sites on interstate routes are: Savannah River Site, 402 km (250 mi); Oak Ridge

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When explosives are being handled, the explosive safety arc is approximately 3,400 m (11,200 ft) around the pier area. The existing State highway through the site is closed off about 3 km (2 mi) from the piers at the small town of Clyde (population about 485) adjacent to the Station's Administrative areas (Yocum, 1994b). Concord NWS area has its own full-time security force, with a U.S. Coast Guard facility onsite to provide some explosive oversight services during loading and unloading activity. There is a fire



responders.

The primary mission of the port is to support all branches of the military in shipping munitions. No concurrent non-explosives cargo handling, such as foreign research reactor spent nuclear fuel, would be allowed when explosives are being handled. Scheduling of foreign research reactor spent nuclear fuel shipments would have to be done for times when no explosives handling is anticipated. Unscheduled activities or activities with little advance notice involving the military mission would require re-scheduling or re-routing of the foreign research reactor spent nuclear fuel. The foreign research reactor spent nuclear fuel handling would not be the first priority of the port.

Conflicting activities are expected to be avoided by proper scheduling (normally only one ship at a time is in port).

Parts of the tidal area are leased to local cattle growers to keep the grass down for fire protection purposes. The station is a wildlife sanctuary for migratory birds (about 1,200 ha or 3,000 acres) of the tidal area) and hosts native Tule elk, which were formerly on the endangered species list (Yocum, 1994b).

Portions of the inland area at Concord NWS serve as a sanctuary for Tule elk, a formerly endangered species (Yocum, 1994b). Other terrestrial species found in the area include the river otter, the salt-marsh harvest mouse (a Federally protected species), and the white-tailed kite (FWS, 1981e; FWS, 1981f). Adult concentrations and nesting areas of the California clapper rail (a Federally protected bird species) and the California black rail (a State protected species) are also found in this area. The U.S. Fish and Wildlife Service reports that the following Federally-listed, protected species may occur in Contra Costa County: winter-run chinook salmon (endangered), delta smelt (threatened), bald eagle (endangered), American peregrine falcon (endangered), Aleutian Canada goose (threatened), California brown pelican (endangered), California clapper rail (endangered), California least tern (endangered), and the salt marsh harvest mouse (Medlin, 1994). The Federally and State protected figwort plant family is also found in the vicinity of Concord NWS. In general, the greater San Francisco Bay area annually supports large numbers of shorebirds, wintering waterfowl, raptors, seabirds, and passerlings. In addition, shorebirds, wading birds, waterfowl, seabirds, and songbirds migrate through this coastal area.

Climatic Conditions

Currently, there is no operational National Weather Service station located in Concord, CA. However, the National Weather Service does operate stations at the San Francisco International Airport (37° 37' N, 122° 23' W) and at the San Francisco Executive Airport (37° 37' N, 122° 23' W).

entrance the currents are variable, and at times reach a velocity of [2.6 meters-per-sec] 5 knots on the ebb; on the flood [tide] they seldom exceed [2.1 meters-per-sec] 4 knots. Since logging is one of the main industries of the region, free floating logs and submerged deadheads or sinkers are also a source of danger. The danger is increased during spring freshets" (DOC, 1992b).

U.S. Coast Guard statistics for 1990 through 1993 indicate that the transit from the Pacific Ocean to the Port of Portland is hazardous, with a reported total of 112 ship collisions and 145 (hard) groundings (USCG, 1994b). It is noted that a large number of oceangoing vessels make the transit on a routine basis without incident. Since some of these accidents were most likely associated with barges, it is believed that the actual rate for oceangoing vessels is probably lower.

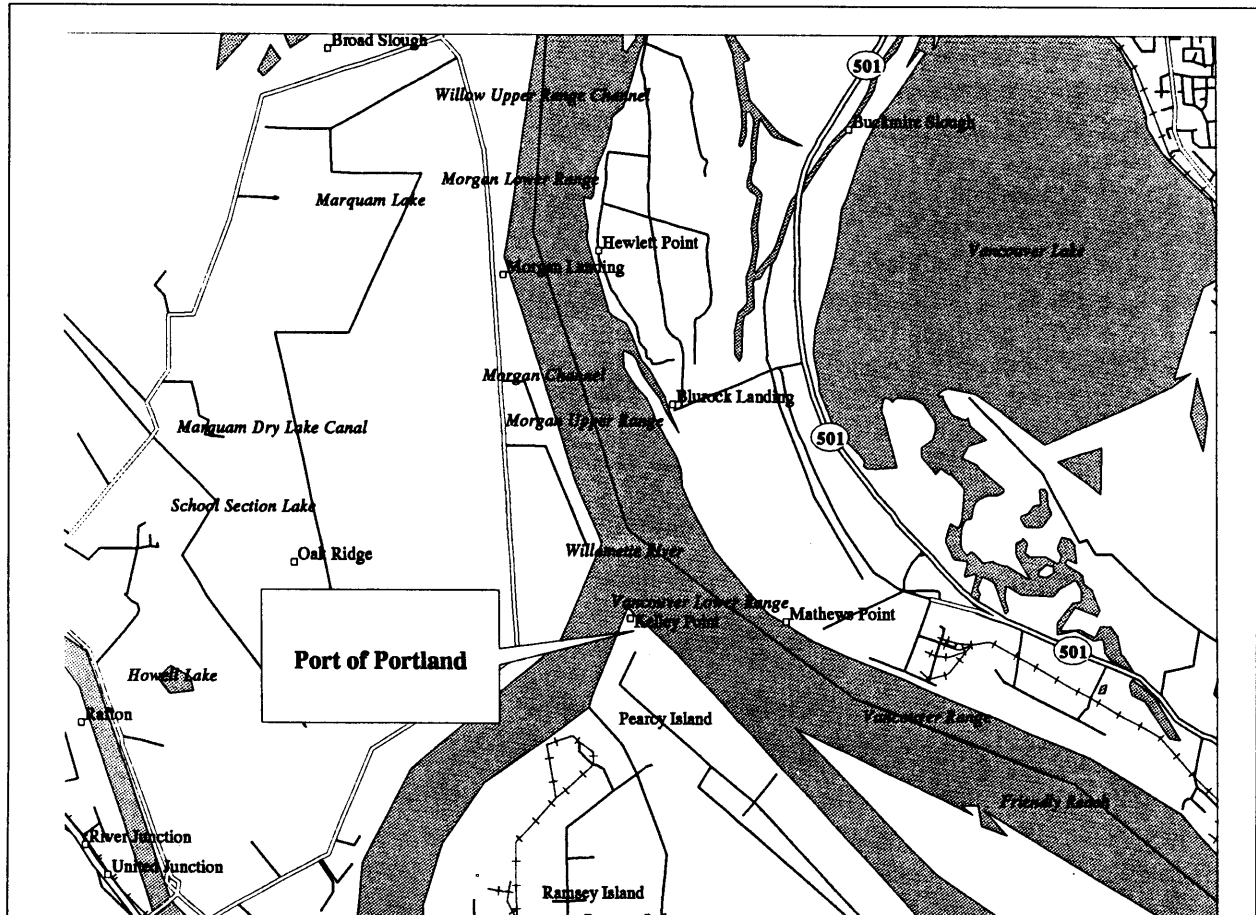
The Port of Portland owns and operates Terminal T6, a deep-water dedicated container facility located on Percy Island, at the confluence of the Columbia and Willamette Rivers, about 140 km (90 mi) from the ocean entrance to the Columbia River. The port also owns other terminals (including T2, a container/breakbulk facility), all of which lie further upstream of Terminal T6. Terminals are situated in an industrial port district northwest and seaward of downtown Portland (POP, 1994). A map of the port is shown in Figure D-28.

The port is served by several container lines including Australia New Zealand Direct Line, Evergreen Line, Hanjin Shipping Co., LTD., Hawaiian Marine Lines, Hyundai, International Marine Transport Lines, Italian Line, d'Amico Line, Jebson's International, "K" Line, Mitsui OSK, Neptune Orient, NYK Line, Pacific Commerce Line, Safbank Line, and United Yugoslav Line (Jane's, 1992; AAPA, 1993; POP, 1994).

Terminal T6: This terminal has three berths, five container cranes [two 36.3 metric ton (40 ton) and one 50 metric ton (55 ton)], a container freight station, distribution warehouse, and rail/barge service. It has about 869 m (2,851 ft) of marginal wharf, with 12.2 m (40 ft) of water alongside at mean low water. Truck access to Interstate 5 is via North Marine Drive and N. Lombard Street, both of which connect with I-5 about 5.5 km (3.4 mi) from the terminal entrance. North Marine Drive is an industrial use roadway that connects with I-84, the assumed route to Idaho National Engineering Laboratory, north and across the Willamette River from downtown Portland. T6 is served by the Burlington Northern and Union Pacific Railroads, whose tracks reach to within about 0.5 km (1,500 ft) of the container berths; an intermodal, container-on-flat-car rail yard is an integral part of the terminal. T6 has reciprocal switching arrangements with the Southern Pacific Railroad (AAPA, 1993; POP, 1994).

T6 is located north (downstream) of the port's other marine terminals and has no apparent conflict with other hazardous cargoes. It is currently operated by the port, but the port is considering an operations contractor for the future (Hachey et al., 1994).

Terminal T2: This terminal has about 833 m (2,730 ft) of marginal wharf, with 12.2 m (40 ft) of water alongside at mean low water, and four container cranes with capacities ranging from 33 metric tons (36 tons) to over 77 metric tons (85 tons). Truck access to Interstate 84 is via Interstate 5 South to U.S. Route 30 West, connecting with I-84 at Maywood Park, a total distance of about 19 km (12 mi). The terminal is served by the Portland Terminal Railroad and the Burlington Northern, and has direct ship-to-rail transfer capability. T2 also has reciprocal switching arrangements with the Southern Pacific (AAPA, 1993; POP, 1994). T2 is located near several large bulk petroleum terminals that are undoubtedly supplied by tankers. Such traffic was not considered to be a major risk factor for the transportation of spent nuclear fuel to Portland. However, because of the potential conflicting uses, Terminal T6 is the preferred facility.



Other Pertinent Information: Security is provided by perimeter fencing and the port's police force, which maintains a 24-hour patrol and surveillance function at both terminals.

There are no restrictive regulations currently affecting the potential receipt and transport of foreign research reactor spent nuclear fuel through the port. The Manager of Marine Market Development indicated that the port has not handled spent nuclear fuel since 1985, and there is opposition to handling nuclear materials by the port's labor unions (Magness, 1993). It is noted that while most of the spent nuclear fuel shipped through Portland had been shipped by the end of 1985, other data sources indicate the port also handled additional spent nuclear fuel in 1989 (NRC, 1993; SNL, 1994). There are no restrictions on Class A or B explosives, and the Coast Guard does not make radiation surveys of radioactive cargoes. Recently, the port could not get shippers to handle naturally radioactive columbium concentrate from British Columbia even if it is not unloaded (Hachey et al., 1994). While this does not preclude foreign research reactor spent nuclear fuel shipments, this indicates there is the potential for delays which could result in failing to "expeditiously transfer" foreign research reactor spent nuclear fuel from the port to a selected storage site.

Portland has a Port Evacuation Plan and a hazardous materials advisory staff (Hachey et al., 1994). The State Health Division with whom the port confers, has a resident nuclear physicist for technical assistance. The port is also a member of the Maritime Fire and Safety Association (an industrial association representing 27 terminal operators) and nine fire departments on the Columbia and Willamette Rivers. The nearest fire station can respond within about six minutes (Hachey et al., 1994). The Association has developed emergency response plans and is implementing a radio communications system covering the entire river system from Astoria to Portland. The City fire department and Coast Guard respond to accidents involving hazardous materials cargoes. Port operating personnel and longshoremen receive general instruction concerning handling of hazardous materials cargoes (Magness, 1993). In addition, the port has contractors ready to respond to hazardous materials accidents when necessary (Hachey et al., 1994). There has not been a severe container accident in at least 10 years, so no port accident statistics were available (Hachey et al., 1994). The port is located several miles downstream from Portland's business and residential districts in an area that appears dedicated to port industrial usage, but as already noted, has excellent connections with highways and rail service.

There are no known areas of special environmental concern in the immediate vicinity of the port, although concern for the environment runs high throughout the Pacific Northwest. A "critical habitat" adjacent to Terminal 6 will have to be mitigated with the planned expansion at T6, but there are no plans to fill wetlands between T6 and populated areas about 1 or 2 km (0.6 or 1.2 mi) away (Hachey et al., 1994).

The port is subject to earthquakes and volcanism. The likelihood of severe natural phenomena, such as high winds and earthquakes is reflected in the structural requirements for buildings in each area of the United States. These are shown in the Uniform Building Code (UBC, 1991). For the Port of Portland, the Uniform Building Code requires buildings to withstand wind speeds up to 140 km/hr (90 mph). The port is located in a moderate seismic zone with an acceleration of 0.20 g. There have been two major earthquakes in the Puget Sound area this century; a Modified Mercalli Intensity (MMI) VIII on April 13, 1949, and an MMI VII-VIII on April 29, 1965 (Bolt, 1978). On May 18, 1980, nearby Mount St. Helens suffered a major volcanic eruption (IPA, 1993). All the mountains along the Cascade Range are volcanic in origin and prone to eruption (Foster, 1971; Hamilton, 1976; IPA, 1993).

The 1990 census population within 16 km (10 mi) of the Terminal was 356,064. The affected populations within 0.8 km (0.5 mi) of the interstate routes to the five potential DOE management sites are: Savannah River Site, 686,000; Oak Ridge Reservation, 519,000; Idaho National Engineering Laboratory, 143,000; Hanford Site, 85,700; and Nevada Test Site, 375,000. Populations along rail routes to these sites are

slightly smaller for Nevada Test Site and Idaho National Engineering Laboratory, but slightly larger for Savannah River Site, Oak Ridge Reservation, and Hanford Site. These populations are shown in Figures D-8 through D-17 in Section D.1. The distances to the five potential sites on interstate routes are: Savannah River Site, 4,630 km (2,879 mi); Oak Ridge Reservation, 4,200 km (2,609 mi); Idaho National Engineering Laboratory, 1,190 km (738 mi); Hanford Site, 407 km (253 mi); and Nevada Test Site, 2,040 km (1,270 mi). Distances along rail routes are slightly longer, with the exception of Hanford Site, which is slightly less.

Environmental Conditions

The areas surrounding the Terminal are in river-oriented industrial land use. Wildlife habitat along the Oregon Slough is limited because of the industrial development, although some waterfowl use the area. While the primary uses in the Terminal area are commercial navigation and industry, some recreational fishing and boating occurs in Oregon Slough and the Columbia River (Kurkoski, 1994).

The U.S. Fish and Wildlife Service's Ecological Inventory for the Vancouver, Washington-Oregon area indicates that the Columbia River generally includes the following fish species: salmonids, chinook salmon, coho salmon, chum salmon, pink salmon, sockeye salmon, steelhead trout, Dolly Varden, smelts, river lamprey, white sturgeon, American shad, eulachon, and cutthroat trout (FWS, 1981d). South of Portland, the various islands and wetlands along the Columbia River provide habitat for a wide variety of terrestrial organisms. Areas of special interest include the Sauvie Island Game Management Area, which is located approximately 8 km (5 mi) downriver of Terminal 6, and the Ridgefield National Wildlife Refuge, which is approximately 16 km (10 mi) downriver.

The U.S. Army Corps of Engineers reports that raptors such as the red-tail hawk, bald eagle, and peregrine falcon are occasional visitors to this area and that the U.S. Fish and Wildlife Service has indicated that the endangered American peregrine falcon and threatened bald eagle may winter in this area. In addition, the National Marine Fisheries Service has listed the Snake River sockeye salmon as endangered, and two Snake River chinooks stocks as threatened (Kurkoski, 1994). The State of Oregon's Natural Heritage Program reports that there are at least two rare species that occur in the vicinity of Terminal 6 (Gaines, 1994). These species are the painted turtle (a State-Sensitive-Critical species) and the Columbia water-meal.

Climatic Conditions

The city of Portland is situated midway between the northerly oriented low coast range on the west and the higher Cascade range on the east. The Cascade range provides a steep slope for orographic uplift of moisture laden air arriving on westerly winds from over the Pacific Ocean, resulting in moderate rainfall events in the area. The prevailing winds are generally northwesterly during spring and summer, becoming more southeasterly in fall and winter. The Portland area is characterized by a winter rainfall regime, where approximately 88 percent of the annual total falls during October through May. Thus, the winter season is dominated by relatively mild temperatures, cloudy skies and rain accompanied by southeasterly surface winds. Summer produces pleasantly mild temperatures, northwesterly winds and very little precipitation. Fall and spring are traditional seasons with variable characteristics. Fog generally occurs most frequently during fall and early winter. Destructive storms are infrequent in this region of the United States, and surface winds rarely exceed gale force. Thunderstorms occur monthly through the spring and summer, with gentle rains occurring almost daily during the winter months. Based on the 1951-1980 climatology, the first frost occurs on average around November 7, with the last spring frost occurring near April 3 (NOAA, 1992f).

D.2.1.8 Savannah, GA

The Port of Savannah is located on the South Bank of the Savannah River, about 35 km (22 mi) above the entrance from the Atlantic Ocean. Savannah is the third largest city in Georgia, and is the chief port of the State of Georgia. A Federal Project maintains 12.2 m (40 ft) of water through Tybee Roads, then 11.6 m (38 ft) for about 16 mi in the main channel to the turning basin at Kings Island (DOC, 1993d). A map of the port is shown in Figure D-29.

Under normal conditions, currents at the entrance to Savannah are 1.1 to 1.5 metric-sec (2.2 to 3.1 knots) during the ebb tide, and 0.8 to 1.2 metric-sec (1.6 to 2.4 knots) during the flood tide. It has been reported that currents in the river can reach 3.6 to 4.1 metric-sec (7 to 8 knots) in the vicinity of Garden City Terminal just below the Route 17A bridge and at the Colonial Oil Berths, about 4 km (2.5 mi) above the bridge. Access to the port can be complicated due to some relatively narrow sections of the channel

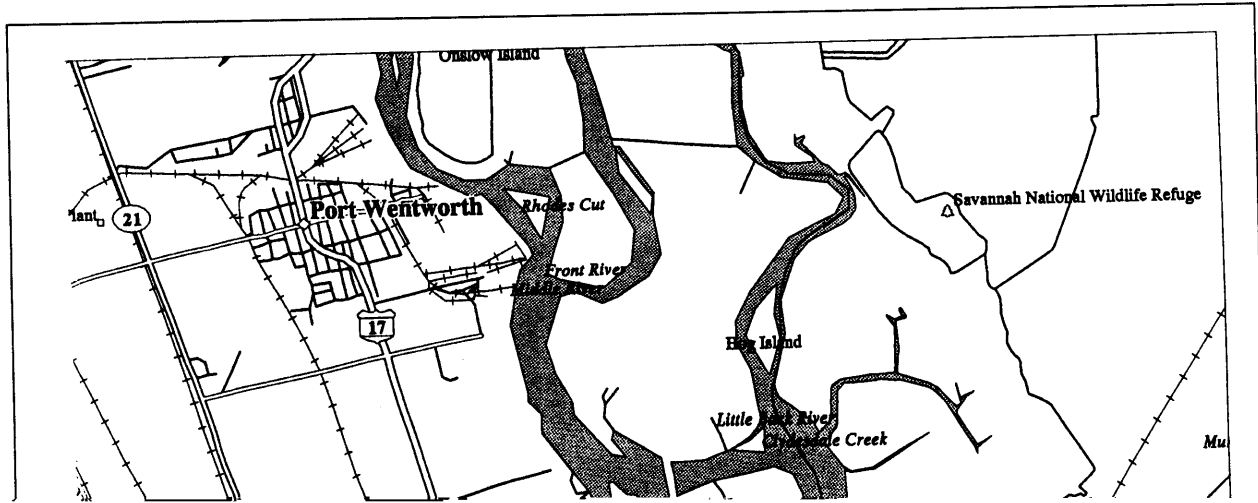
The Georgia Ports Authority (GPA) operates three large cargo terminals on the South Bank of the Savannah River. Ocean Terminal, located approximately 41 km (25 mi) from the river entrance in the City of Savannah, is a combination breakbulk and container handling facility; Garden City Terminal is about 4.6 km (2.9 mi) further upstream from Ocean Terminal. Containerport, part of the Garden City terminal complex, is a dedicated container handling facility. The depth alongside both container terminals is 11.6 m (38 ft), and dredging to 12.7 m (42 ft) is in progress.

The port is served by more than 50 container and breakbulk ship lines, including several major container carriers, with itineraries to some 100 countries in the world, including many in Europe and the Far East, as well as Japan, and Australia (Jane's, 1992; AAPA, 1993; Southern Shipper, 1993)

Ocean Terminal: This facility has 10 berths, a 61 m (200 ft) apron, extensive Transit sheds and warehouse space, with 34 ha (83 acres) of open storage. It has one 41 metric ton (45 ton) single hoist container crane and four gantry cranes of greater capacity, and 1,825 m (5,990 ft) of marginal wharf; Berth 13, the longest, is 297 m (975 ft) long. The terminal has almost immediate access to U.S. Route 17 (north/south), and connects with I-16 a few city blocks from the terminal. The terminal is served by the Norfolk Southern and CSX railroads (AAPA, 1993; Southern Shipper, 1993; Jane's, 1992). Due to its close proximity to the City, it is not a preferred container terminal.

Containerport: This is the preferred container terminal, due to its better separation from the City and

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show it has (SNL, 1994; NRC, 1993). The port has a hazardous materials training staff but no Emergency

Response Team. Reportedly, the GPA contracts with outside firms to respond to oil and other hazardous materials accidents.

There are tanker berths and petroleum storage facilities adjacent to Containerport's facilities, and there are several private bulk liquid storage facilities downstream of Containerport (towards the City), including a liquid natural gas terminal a few miles above the Pilot station. The presence of these terminals along a river channel only 152 m (245 ft) wide with swift currents, and the increasing number of container ships with lengths in excess of 250 m (820 ft) heighten the possibility of potentially serious conflicts within the port.

The port is subject to severe hurricanes and tropical storms, and given its proximity to Charleston, SC may have a slightly higher risk of earthquakes than the rest of the State of Georgia. The likelihood of severe natural phenomena, such as high winds and earthquakes, is reflected in the structural requirements for buildings in each area of the United States. These are shown in the Uniform Building Code (UBC, 1991). For the Port of Savannah, the Uniform Building Code requires buildings to withstand wind speeds up to 130 km/hr (80 mph). The port is located in a low seismic zone with an acceleration of 0.075 g.

The 1990 population within 16 km (10 mi) of the port terminals was 155,166. The affected populations within 0.8 km (0.5 mi) of the interstate routes to the five potential DOE management sites are: Savannah River Site, 37,300 ; Oak Ridge Reservation, 101,000; Idaho National Engineering Laboratory, 553,000; Hanford Site, 602,000; and Nevada Test Site, 616,000. Populations along rail routes to these sites are slightly larger. These populations are shown in Figures D-8 through D-17 in Section D.1. The distances to the five potential sites on interstate routes are: Savannah River Site, 400 km (250 mi); Oak Ridge Reservation, 720 km (440 mi); Idaho National Engineering Laboratory, 2,860 km (2,200 mi); Hanford Site, 1,100 km (680 mi); and Nevada Test Site, 1,100 km (680 mi).

River also is reported to be an important spawning area for striped bass (Laumeyer, 1994). In addition, the loggerhead turtle, bald eagle, and the American alligator are found along the lower reaches of the Savannah River (FWS, 1980c).

Both invertebrate and fish species of commercial and recreational value found in the Savannah River. Commercial fishing is primarily for American shad, sturgeon, shrimp, and blue crab. Public shellfishing is allowed in some areas near the mouth of the Savannah River in the vicinity of Fort Pulaski. The Savannah River is host for the migration of several important commercial and game fishes including the American shad, the hickory shad, and the blueback herring. Game species include the spotted seatrout, red drum, croaker, spot, striped bass, flounder, silver perch, white catfish, channel catfish, large mouth bass, sunfish, and crappies. The State of Georgia has closed the striped bass fishery for population recovery purposes. Results of a seasonal creel survey of the Savannah River estuarine fishery, conducted by the Georgia Department of Natural Resources from October 20, 1992 to February 16, 1993 found that the estimated angler harvest for that time period was 10,893 fish. White catfish (28.4 percent), spotted seatrout (27.9 percent), red drum (17.9 percent), and silver perch (10.4 percent) represented approximately 85 percent of the fish harvested from the Savannah River during this time period (Schmitt, 1993).

There are several wildlife refuges and/or game management areas located along the lower portion of the Savannah River. Tybee National Wildlife Refuge is located at the mouth of the Savannah River at the confluence with the Atlantic Ocean. Just north of Tybee National Wildlife refuge is the Turtle Island Game Management Area. The Containerport itself is located across the river from the southern end of the 10,371 ha (25,608 acre) Savannah National Wildlife Refuge. The Savannah National Wildlife Refuge and the Tybee National Wildlife Refuge are managed by the U.S. Fish and Wildlife Service.

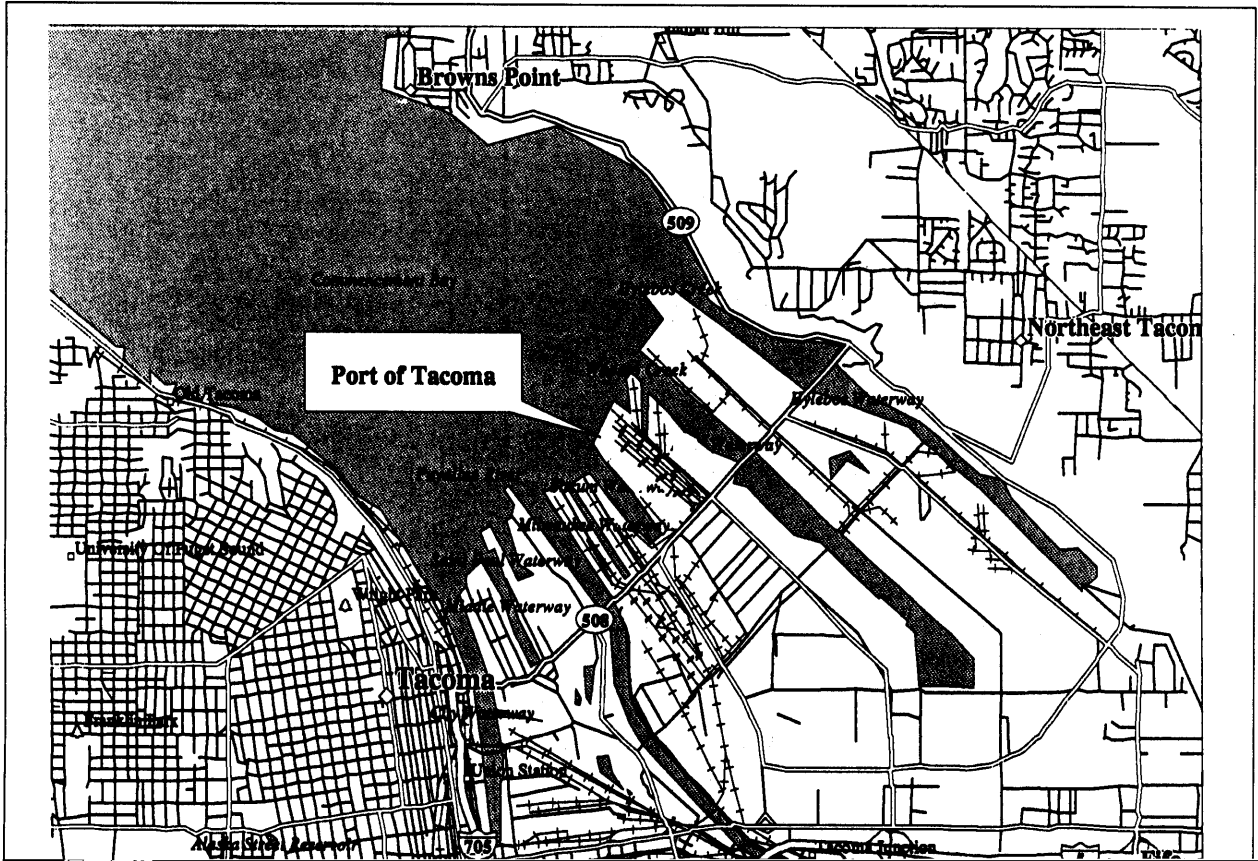
Climatic Conditions

The Port of Savannah, GA, is located in Chatham County on the Savannah River. The city of Savannah is surrounded by low, flat terrain that is marshy to the north and east and rises to a few meters (several ft) above sea level to the west and south.

The area has a temperate climate which, again, is greatly influenced by winds coming into the area off of the surrounding ocean. Nominally, 50 percent of the rainfall occurs during thunderstorms with the remainder being equally distributed over the year and generally related to frontal passages. Severe tropical systems affect the Savannah, GA, area roughly once every 10 years and cause heavy, sustained precipitation, high winds, and extreme localized coastal flooding. Rainfall measurements in excess of 51 cm (20 in) have been observed as a result of tropical systems impacting the area. Based on the 1951-1980 climatology, the first freeze occurs on average around November 15th and the last freeze occurs near March 10th (NOAA 1992d).

D.2.1.9 Tacoma, WA

The Port of Tacoma is located in the southeastern corner of Puget Sound on the deep waters of Commencement Bay, about 5 km (3 mi) from the Sound. It is a rapidly expanding major port, second only to Seattle in maritime importance on Puget Sound. Like Seattle, access is gained via the Straits of Juan de Fuca and Puget Sound. The distance from the entrance into Puget Sound is approximately 130 km (80 mi). While the transit is open with deep wide channels, it is a relatively long distance on an inland waterway (DOC, 1992b). The port currently handles about 1,054,000 20-ft equivalent container units, amounting to 6.7 million metric tons (7.4 million tons) of cargo (AAPA, 1994). A map of the port is shown in Figure D-30.



The port functions as a special purpose district operation under State enabling legislation and is governed by a Board of Commissioners. The Commission owns and operates several terminals, including container and roll-on/roll-off facilities. Stevedoring is performed by private contractors and/or by ship lines leasing facilities from the port.

Commencement Bay has been designated a "Superfund Site" by the Environmental Protection Agency. However, since the acceptance of spent nuclear fuel through the Port of Tacoma would neither affect the activities being conducted in response to the "Superfund Site" designation, nor would it add any additional burden to this designation, the "Superfund Site" designation has no bearing on the proposed action.

Berths A, B, and C of Terminal 7 are primarily public general cargo facilities handling breakbulk and dry bulk cargoes. Depths alongside range from about 12.2 m to 15.2 m (40 to 50 ft), and it has two 36 metric ton (40 ton) gantry cranes and one 36 metric ton (40 ton) multi-purpose bulk unloading crane. Terminal 7, Berth D (Husky Terminal) is the primary container terminal, and has one 274 m (900 ft) long container berth, 3 container cranes [two 45 metric ton (50 ton) and one 50 metric ton (55 ton)], and 15.2 m (50 ft) of depth alongside at mean low water. It has 14 ha (33 acres) of terminal area with access to the 9,512 m² (102,400 ft²) container freight station and a 8,920 m² (96,000 ft²) transit warehouse located near Berths A and B.

The Husky Terminal is about 4.8 km (3 mi) from the Port of Tacoma road access (Exit 136) to Interstate 5 immediately outside the port complex. While a somewhat longer route, Interstate 5 South connects with I-84 East near Portland, OR, avoiding the added risks of trucking spent nuclear fuel over Snoqualmie Pass to Eastern Washington during the winter. Ship berths are served by the Port Belt Line Railroad, and the port is served by the Burlington Northern and Union Pacific Railroads, which interline with eastern and southern railroads. All Terminal 7 berths are adjacent to the North Intermodal Railroad Yard, which consists of 10.4 ha (26 acres) of yard area and 5,340 m (17,500 ft) of trackage. A second intermodal rail terminal, the South Intermodal Rail Yard, is also located within the port for use by all port shippers (Jane's, 1992; AAPA, 1993; POT, 1994).

Tacoma is served by over a dozen containership and breakbulk ship lines including ELMA, Evergreen, Hyundai, IMT, "K" Line, Maersk, MOL, Navianca, Naviera Pacifico, NOSAC, PCL, Sea-Land, South Pacific Interline, Totem Ocean Trailer Express, Wallenius, and Wallno (Jane's, 1992; AAPA, 1993). These lines provide service with most of the Pacific Rim, including Australia and Japan, and also have service with the Mediterranean (Jane's, 1992; AAPA, 1993).

Other Pertinent Information: According to the port's Director of Risk Management, shipments of spent nuclear fuel could be prohibited by the City of Tacoma Harbormaster's Office, but no formal regulatory restriction was identified. The port has had no identifiable experience with shipment of spent nuclear fuel (SNL, 1994; Paulsen, 1993; NRC, 1993). Security is maintained at Terminal 7 by the port Police around the clock, with locations for segregation and temporary storage of hazardous cargoes (special guards would have to be provided by the shipper for spent nuclear fuel) (Paulsen, 1994). The Tacoma Fire Department provides response for accidents, and the port security personnel are trained in emergency response in cooperation with the Fire Chief (McLendon, 1994). There is also the possibility that the Husky Terminal may begin handling ammonium nitrate in bulk, which (because of the explosion potential) would have to be considered in the event the port were to receive spent nuclear fuel shipments (Paulsen, 1994). The U.S. Coast Guard accident statistics for the period 1991-1993 for the Puget Sound indicate a total of 54 reportable accidents (USCG, 1994b). Given the high volume of ship traffic, the accident frequency is considered to be low.

As is the case with Seattle, there is substantial environmental concern about environment damage, and the entire Puget Sound area is subject to severe earthquakes and volcanism. The likelihood of severe natural phenomena, such as high winds and earthquakes, is reflected in the structural requirements for buildings in each area of the United States. These are shown in the Uniform Building Code (UBC, 1991). For the Port of Tacoma, the Uniform Building Code requires buildings to withstand wind speeds up to 130 km/hr (80 mph). The port is located in a high seismic zone with an acceleration of 0.30 g. There have been two

Commencement Bay has been designated a "Superfund Site" by the Environmental Protection Agency. However, since the acceptance of spent nuclear fuel through the Port of Tacoma would neither affect the activities being conducted in response to the "Superfund Site" designation, nor would it add any additional burden to this designation, the "Superfund Site" designation has no bearing on the proposed action.

Climatic Conditions

See Section D.2.2.21 (Seattle) for climatic information, since conditions in Tacoma, WA are essentially the same.

D.2.1.10 Wilmington, NC

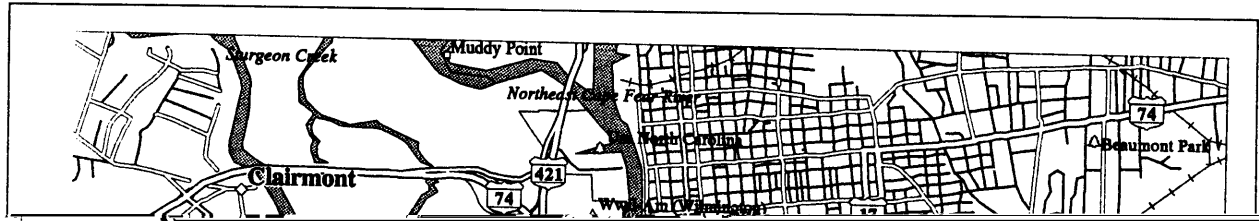
The Port of Wilmington, NC is located on the east bank of the Cape Fear River, about 42 km (26 mi) above its mouth on the Atlantic Ocean. It is the leading port of North Carolina, and its major export is wood pulp. It handles about 110,000 20-ft equivalent units per year, representing about 30 percent of total tonnage. The major terminals are down river from the city. A Federal project maintains a 12.2 m (40 ft) channel over the ocean bar into the Cape Fear River, and then 11.6 m (38 ft) to the port. A new dredging program will deepen the approach channel to 12.2 m (40 ft). The approach to Wilmington, up the Cape Fear River, is more open than many river approaches but has restricted segments. The minimum channel width is about 120 m (400 ft). Currents in the river conform to the channel (DOC, 1993d; FHI, 1993c; NCSA, 1994). A map of the port is shown in Figure D-31.

The port is owned and operated by the North Carolina State Ports Authority (NCSA), a State agency. It is a modern container and general cargo facility with over 92,900 m² (more than a million ft²) of covered, sprinklered storage and a total of 11 berths, two of which are open. The port has over 40 ha (100 acres) of paved, open area and 10 ha (25 acres) of semi-improved storage area. The Wilmington wharves are of concrete pile construction, rubber fendered, with a total frontage of about 2,000 m (6,568 ft). Berths 6 to 9 are dedicated containership berths with the remaining berths used for various kinds of general cargo. All of the main cargo berths have a depth alongside at mean low water of 11.6 m (38 ft). The terminal has three, 40.6 metric ton (45 ton) container cranes and two, 50.8 metric ton (56 ton) container cranes, plus three gantry cranes ranging from 40.8 metric ton (45 ton) to 204 metric ton (225 ton) (Jane's, 1992; AAPA, 1994; FHI, 1993c; NCSA, 1994).

Terminal access via truck is through the controlled South Gate Container Entrance. Truck shipments of spent nuclear fuel from Wilmington to southern destinations are from U.S. Routes 17, 74, 76 and 421 to Interstates 95 and 40. The local routes are accessed about 3 km (2 mi) north of the terminal where they cross the Cape Fear River using the lift bridge. Northern and western long distance routes are via Interstate 40 which connects with State Highway 132 about 16 km (10 mi) north of the city. Wilmington container berths are served shipside by the port rail system and the CSX Railroad. There is also an intermodal trailer-on-flat-car and container-on-flat-car rail yard within the container port. While not currently operational, the port is negotiating with CSX for resumption of intermodal rail service at that facility. At the present time, most rail cargo which requires intermodal connections is trucked to the Charlotte Intermodal Terminal (Wilson, 1995).

The port is serviced by over 30 container lines, including Yang Ming, Polish Ocean, Allied Scandinavian, Central Gulf, Zim, Hanjin and Turkish Cargo Line, plus several regularly scheduled breakbulk shipping companies. These lines provide service from Northern Europe, the Mediterranean, Mideast, East and South Africa, South America, the Far East, Australia, and other shipping centers of the world (Southern Shipper, 1993; Jane's, 1992).

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Other Pertinent Information: There are no known restrictions on the receipt and handling of spent nuclear fuel through the port, although the Mayor has provided notice that the city is not convinced that the port is desirable for spent nuclear fuel shipments (Betz, 1994). This position was echoed by the Port's Executive Director, who noted that permission to visit the port must come from the State Port Commission, and that the Governor was opposed to handling spent nuclear fuel at State ports (Scott, 1994). Wilmington has handled the import shipments of enriched uranium for nuclear fuel fabrication consigned to a General Electric commercial nuclear fuel fabrication plant north of Wilmington, the exports of the finished nuclear fuel assemblies, and has also handled containerized Class A explosives (Wilson, 1993). The Sandia National Laboratories Radioactive Materials Postnotification Database was queried in April 1994, and the data showed that Wilmington received two shipments of spent nuclear fuel from Japan on February 3, 1986 and transhipped the casks to Savannah River Site the same day (SNL, 1994).

The port is located several miles downstream of the business district in an area of increasing industrial development, although there is some residential housing bordering the complex. The Military Ocean Terminal at Sunny Point is also located on the Cape Fear River, north of Southport, NC, and south of Wilmington, NC.

Port officials are part of an emergency response team headed by the Coast Guard and the Wilmington Fire Department. There are two fire stations within 3 km (2 mi) of the port, with a 5-minute response time (Scott, 1994). All operational personnel working within the terminal, including longshoremen, are given basic hazardous materials training, but training does not deal specifically with spent nuclear fuel.

Security at the port is provided by a 2 m- (6 ft-) high perimeter fencing topped with barbed wire, and a North Carolina State Ports Authority Police Force, which maintains a 24-hour patrol and surveillance. Armed officers are commissioned by the City Police Department, and unarmed guards at the gates are employed by the port (Scott, 1994). A North Carolina State Ports Authority Safety Manager reports to the Director of Operations and is responsible for all safety aspects of the terminal. A tanker terminal and petroleum storage depot are located immediately adjacent downstream of the port. Immediately north of the terminal, on the same side of the river, is an asphalt and chemical storage marine terminal. There is little ship traffic on the River, north or south of the State docks, and therefore there is little conflicting traffic or cargoes.

There are no known environmentally sensitive areas in the immediate vicinity of the terminal, but due to ~~near resorts and recreational activity~~ there is heightened environmental awareness. The port is subject to

hurricanes and tropical storms, as discussed below.

The likelihood of severe natural phenomena, such as high winds and earthquakes, is reflected in the structural requirements for buildings in each area of the United States. These are shown in the Uniform Building Code (UBC, 1991). For the Port of Wilmington, the Uniform Building Code requires buildings to withstand wind speeds up to 160 km/hr (100 mph). The port is located in a low seismic zone with an acceleration of 0.075 g.

The 1990 population within 16 km (10 mi) of the port terminals was 115,057. The affected populations within 0.8 km (0.5 mi) of the interstate routes to the five potential DOE management sites are: Savannah River Site, 64,700; Oak Ridge Reservation, 128,000; Idaho National Engineering Laboratory, 507,000; Hanford Site, 556,000; and Nevada Test Site, 570,000. Populations along rail routes to these sites are slightly longer. These populations are shown in Tables D-7 through D-16 in Section D.1. The distances to

Reservation, 820 km (509 mi); Idaho National Engineering Laboratory, 4,100 km (2,546 mi); Hanford Site, 4,770 km (2,963 mi); and Nevada Test Site, 4,260 km (2,650 mi). Distances along rail routes are slightly longer for Western sites, but about the same for Eastern sites.

Environmental Conditions

North Carolina has given the lower portion of the Cape Fear River three different stream classifications. From the Northeast Cape Fear River to the confluence with the Cape Fear River the waters are classified as SC-swamp. From the mouth of the Northeast Cape Fear to a point between Snow and Federal Points, the waters are classified as SC. From Snow and Federal Points oceanward the waters are classified as SA. SC waters are tidal waters suitable for fishing, fish and wildlife propagation, secondary recreation and other water uses requiring lower quality. The term "swamp" denotes waters with slow velocity. Class SA waters are suitable for shellfishing, primary recreation, as well as all of the activities approved for Class SC waters (NCDEHNR, 1992). According to the U.S. Fish and Wildlife Service's Ecological Inventory Map for Beaufort, NC, the Port of Wilmington is located in a low salinity estuarine habitat (generally 0.5 to 5 parts per thousand) and tidal freshwater habitat. Below Wilmington at Campbell Island, the river changes to a mid-salinity estuarine habitat (generally 5 to 16.5 ppt). The Cape Fear River near MOTSU changes once again to a high salinity estuarine habitat (generally 16.5 to 30 ppt) (FWS, 1980a).

The lower Cape Fear River supports a large number of aquatic and terrestrial species. There are both invertebrate and fish species of commercial and recreational value found in the Cape Fear River near the Port of Wilmington. Species sought by commercial and recreational fisherman include flounder, trout, spot, croaker, bluefish, Spanish mackerel, and king mackerel. Shellfish sought include penaeid shrimp and blue crabs.

The Natural Heritage Program of the North Carolina Department of Environment, Health, and Natural Resources reports that the area around the state port has not been systematically inventoried for rare species (Smith, 1994). However, DEHNR reports that the lower Cape Fear River, from Wilmington to the mouth of the river at Smith Island, is brackish and contains numerous rare animals. The shortnose sturgeon (State and Federal Endangered Species) rarely occurs in the river, whereas manatees (State and Federal Endangered Species) occasionally occur, especially in the summer. American alligators (State and Federal Threatened Species) can be found in tributary streams. The freckled blenny, spinycheek sleeper, opossum pipefish, and marked goby are other rare marine fishes that inhabit the river.

A large number of aquatic species may be found in the lower Cape Fear River and along the southern coast of North Carolina (Horning, 1994; U.S. Army, 1993; FWS, 1980a). There are many animals with special status in this area, including various types of whales, sea turtles, and birds. State or Federally protected endangered or threatened aquatic species in this area include the shortnose sturgeon (fish), finback whale,

The maritime location of the Wilmington, NC, area makes the climate unusually mild for its northern latitude. All wind directions from the east-northeast through the southwest have some moderating effect on the local climate, due to the relatively warm and cool ocean in the winter and summer seasons, respectively. The area rarely experiences cold episodes where the temperature falls below -18°C (0°F). However, cold air outbreaks do occur, causing sharp fluctuations in winter temperatures. Rainfall in the area is generally considered ample and evenly distributed throughout the year, with the bulk of the precipitation occurring during the summer months. The bulk of this rainfall is generally associated with afternoon and evening thunderstorms. In contrast, the winter rains tend to be of the slow, steady type lasting, generally, one to two days. As is common at Atlantic coastal localities at this latitude, the late summer and early fall months bring the possibility of hurricanes and tropical storms to the Wilmington, NC area. These storms are capable of generating high winds, above normal tides, and torrential rains. The latter two are also capable of creating widespread local flooding of low-lying coastal areas (NOAA, 1992b).

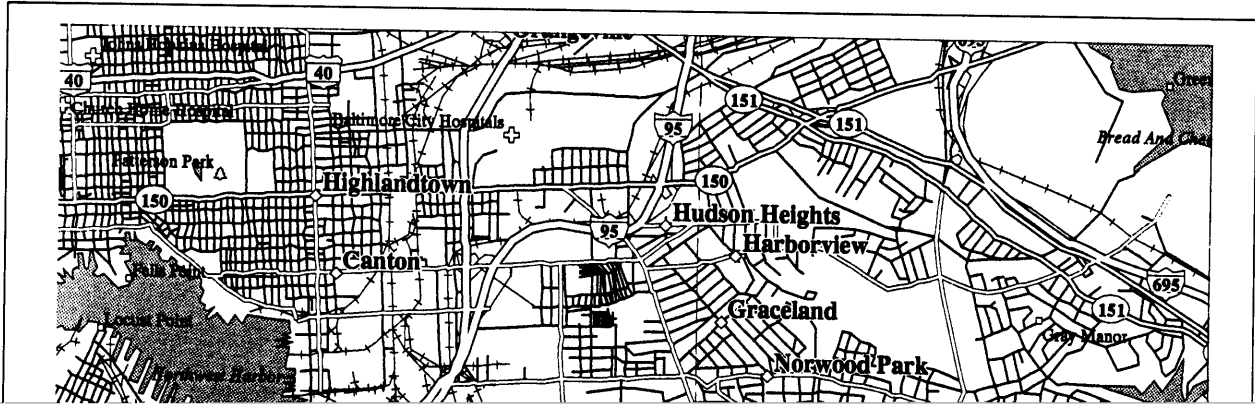
D.2.2 Other U.S. Ports Meeting the Appropriate Experience Criteria

The ports described in this section are those that were initially identified as acceptable based on experience with containerized cargo, but that were subsequently dropped from further consideration based on ~~standing against other criteria. These criteria and~~ the evaluation process are described in Section D.1.

The Port of Baltimore, one of the major ports of the United States, is established on the upper Chesapeake Bay at the head of tidewater navigation on the Patapsco River. It is situated 13 km (8 mi) from the entrance to the Patapsco, 240 km (150 mi) from the Virginia Capes, and 1670 km (104 mi) from the Delaware Capes.

Depths within the harbor range from 15.2 m (50 ft) to 12.2 m (40 ft). Federal project depths are 15.2 m (50 ft) in the main channel between the Virginia Capes and Fort McHenry in the Baltimore Harbor. Access to the port can be gained via the Delaware Bay and River, and the Chesapeake and Delaware Canal, although this route is not recommended due to the restrictive nature of the transit. The preferred

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Dundalk Marine Terminal: Dundalk Marine Terminal, located adjacent and eastward of Seagirt, has approximately 231 ha (570 acres) of terminal area and is a combination container, roll-on/roll-off, and breakbulk handling facility. The terminal has 13 barge and ship berths, 11 cranes, and covered storage shed space of more than 37,000 m² (400,000 ft²). Marginal wharves consist of three 808 m total (2,650 ft), two 553 m total (1,820 ft) container berths, and one 305 m (1,000 ft) container berth. Containership berths have a depth alongside of 11.5 m (38 ft). Crane capacity at the terminal includes nine 40.6 metric ton (45 ton) single hoist container cranes and two 61 metric ton (67 ton) gantry whirley cranes (Jane's, 1992; D&B, 1993; AAPA, 1993 and 1994).

The Seagirt and Dundalk Terminals are located in the Dundalk section of the City of Baltimore, east and south of the central business district. The access road to both terminals is bordered primarily by heavy industrial types of businesses with relatively good interstate highway connections. Southbound, the distance from Seagirt to I-695 is roughly 4 km (2.5 mi). The entrance to the Seagirt Marine Terminal is approximately 1.6 km (1 mi) from I-95 connected by Bruening Highway, an industrial roadway that also serves as the main truck access to both terminals. Access to other major interstate highways is via the I-695 Beltway, which would be used to bypass harbor tunnels for Savannah River Site or other southern destinations. Routing and connect time for Dundalk traffic would be virtually the same due to proximity of location to the Seagirt terminal. Seagirt is served by the CSX Railroad, which operates a 16.2 ha (70 acre) intermodal container transfer facility inside the terminal and within 0.3 km (1000 ft) of the ship berths. Conrail serves the Dundalk Terminal for breakbulk cargoes (D&B, 1993; AAPA, 1993 and 1994).

Other Pertinent Information: Security of both terminals is maintained by the MPA Port Police and is deemed to be excellent. There are secure areas for temporary segregation and storage of containers if necessary.

There are no port restrictions against handling spent nuclear fuel. A port safety officer stated that spent nuclear fuel shipments go out of the port with an armed escort (normally at night), and that the port also handles casks (cylinders) of uranium hexafluoride (UF₆) shipments quite frequently. Although there are no known conflicts with other hazardous materials in the immediate terminal area, there is a diversity of marine terminals and ship traffic activity on the Patapsco River which are not deemed to represent a major hazard factor.

There are no known special environmental issues with regards to handling spent nuclear fuel at Baltimore. The likelihood of severe natural phenomena, such as high winds and earthquakes, is reflected in the structural requirements for buildings in each area of the United States. These are shown in the Uniform Building Code (UBC, 1991). For the Port of Baltimore, the Uniform Building Code requires buildings to withstand wind speeds up to 110 km/hr (70 mph). The port is located in a low seismic zone with an acceleration of 0.075 g.

The MPA relies on the hazardous materials teams of the Baltimore City and County fire departments as well as the Coast Guard for response to hazardous materials accidents. The Maryland Department of the Environment also has input on hazardous materials problems. The MPA has an ongoing hazardous materials training program for all port operating personnel, including the longshoremen. Instruction includes dealing with hazardous wastes (but not spent nuclear fuel in particular) in the soil and groundwater due to the former use of the port site.

The 1990 population within 16 km (10 mi) of the port terminals was 1,182,024. The affected populations within 0.8 km (0.5 mi) of the interstate routes to the five potential DOE management sites are: Savannah River Site, 308,000; Oak Ridge Reservation, 246,000; Idaho National Engineering Laboratory, 482,000; Hanford Site, 531,000; and Nevada Test Site, 665,000. Populations along rail routes to these sites are

much larger. These populations are shown in Figures D-8 through D-17 in Section D.1. The distances to the five potential sites on interstate routes are: Savannah River Site, 1,020 km (636 mi); Oak Ridge Reservation, 925 km (575 mi); Idaho National Engineering Laboratory, 3,790 km (2,354 mi); Hanford Site, 4,460 km (2,770 mi); and Nevada Test Site, 4,060 km (2,526 mi). Distances along rail routes are slightly longer.

Environmental Conditions

The Gunpowder Falls State Park is located approximately 22 km (13 mi) northeast of the port. The Remington Farms Wildlife Reserve, on the Eastern Shore of Maryland, is approximately 35 km (23 mi) east of the port. The Eastern Neck National Wildlife Refuge is located in the Chesapeake Bay, about 38 km (25 mi) southeast of the port area. The Fort McHenry National Monument and Historic Shrine is located on a point of land approximately 4 km (2 mi) west of the Baltimore port. Numerous State Parks and other wildlife refuges are located along the passageway in the Chesapeake Bay south of the port.

The endangered peregrine falcon occurs in the vicinity of the Port of Baltimore (Wolflin, 1994). These birds feed, in part, on shorebirds and other waterbirds using the waters of the Port of Baltimore. The endangered Delmarva fox squirrel and the great blue heron (State-protected) nest on the Eastern Neck Island (FWS, 1980g). The bald eagle (endangered) also nests in the Eastern Neck Island area.

The Bay contains many beds of commercially valuable oysters and soft-shelled clams. Blue crabs are harvested extensively throughout the Bay area. Commercial harvesting of channel catfish and menhaden also is important in the Bay area. Numerous types of fish use the Bay area, including the waters around the port, for nursery areas. Common fish species include the American eel, blueback herring, hickory shad, alewife, gizzard shad, perch, striped bass, drum, flounder, and others. Sport fishing for these fish is also common. State-protected species include the Atlantic sturgeon and American shad (FWS, 1980g). The western bank of the Eastern Shore is a migratory area for the dabbling duck (nonendangered) and a heavily used migration pathway for geese.

Climatic Conditions

Baltimore is in a region about midway between the rigorous climates of the North and the mild climates of the South and adjacent to the modifying influences of the Chesapeake Bay and Atlantic Ocean to the east and the Appalachian Mountains to the west. The net effect is to produce a more equable climate compared to inland locations of the same latitude.

Rainfall distribution throughout the year is rather uniform; however, the greatest intensities are confined to the summer and early fall, the season for hurricanes and severe thunderstorms. Rainfall during this period occurs principally in the form of thundershowers, and rainfall totals during these months vary appreciably, depending on the number of thundershowers that occur largely by chance in a given locality. Hurricane-force winds, however, may occur on rare occasions due to a severe cold front or a severe thunderstorm. The greatest damage by hurricanes is that produced along waterfronts and shores by the high tides and waves.

In summer, the area is under the influence of the large semipermanent high-pressure system commonly known as the Bermuda High and centered over the Atlantic Ocean near latitude 30°N. This high-pressure system brings a circulation of warm, humid air masses over the area from the deep South. The proximity of large water areas and the inflow of southerly winds contribute to high relative humidities during much of the year.

January is the coldest month, and July the warmest. Winter and spring have the highest average windspeeds. Snowfall occurs on about 25 days per year on the average; however, an average of only 9 days annually produce snowfalls greater than 1.0 in. Although heaviest amounts of snow generally fall in February, occasional heavy falls occur as late as March. Records for the period August 1950 through December 1967 indicate that the average date of the last temperature as low as 32° in the spring is April 15, while the average date of the first temperature as low as 32° in the autumn is October 26 (NOAA, 1993a).

Glaze or freezing rain occurs on an average of two to three times per year, generally in January or February, although some occurrences have been noted in November and December. Some years pass without the occurrence of freezing rain, while in others it occurs on as many as eight to ten days. Sleet is observed on about five days annually. The sleet season begins as early as November in some years, and ends as late as March in some cases, with the greatest frequency of occurrence in January (DOC, 1993c).

D.2.2.2 Boston, MA

The Port of Boston is located on Massachusetts Bay about 93 km (50 mi) west of Cape Cod and is the largest seaport in New England. Boston North Channel is the main entrance to Boston Harbor and Boston South Channel and The Narrows are alternative entrances. A Federal project on the North Channel (to the Mystic River) provides for a channel width of 460 m (1,500 ft) and a depth of 12.2 m (40 ft) in the eastern section, and a width of 270 m (900 ft) and depth of 10.7 m (35 ft) in the western section (DOC, 1993a).

Although there are many obstructions in the Harbor approaches, they are marked by a number of powerful lights, and the principal dangers are buoyed. Because of the heavy traffic to the Harbor, there is a traffic separation scheme extending over 160 km (100 mi) out to sea (DOC, 1993a).

The Massachusetts Port Authority (Massport) is a quasi-governmental authority created by the State Legislature in 1956. The Maritime Division is responsible for the operation, development, and maintenance of the port's three public terminals, including two container terminals (Moran and Conley) and one general cargo facility (Harbor Gateway Terminal) (POB, 1993). A map of this port is provided in Figure D-33.

Moran Terminal: Moran Terminal is located about 7.2 km (4.5 mi) upstream of the Inner Harbor Entrance, on the left side of the ascending bank of the Mystic River in Boston's Charlestown section. It is the largest container terminal in New England and is operated by Massport. The facility consists of 20.2 ha (50 acres) of open storage space, storage capacity for 4,000 20-ft equivalent units, and two container cranes [46 and 71 metric tons (51 and 78 tons)]. It has 335 m (1,100 ft) of marginal wharf and depth alongside of 12.2 m (40 ft). Vessels are limited by the 41.2 m (135 ft) clearance under the Tobin Memorial Bridge (Jane's, 1992; AAPA, 1993 and 1994; D&B, 1993; POB, 1993).

Moran Terminal is situated about 1.6 km (1 mi) from the intersection with I-93 with access via city streets through the densely populated Charlestown area. The terminal is served by the Boston & Maine Railroad, whose tracks enter the terminal and extend to the pier apron.

Conley Terminal: The Conley Terminal on Castle Island is less than 6.4 km (4 mi) from the designated entrance to Boston Harbor. The northern approach to the terminal is obstructed by islands and shoals that extend 6.4 km (4 mi) from the entrance for a combined distance of about 13 km (8 mi). It is located at the entrance of the Inner Harbor on the South Boston waterfront. The Terminal is operated by a subcontractor to Massport. It has 305 m (1,000 ft) of marginal wharf, and consists of Berths 11-15, and Berth 17. The depth alongside is 12.2 m (40 ft).

SELECTION AND EVALUATION OF POTENTIAL PORTS OF ENTRY

Δ 777 Δ

Black Rock.

● Fall





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REMARKS:

TREATMENT

RESULTS

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The container terminal, Berth 11, has two 41 metric ton (45 ton) container cranes and an open storage area of 4 ha (9.9 acres). Berth 12 is presently undergoing a \$50 million improvement program (to be completed in 1995), and Berths 13-15 are leased to automobile importers. Berths 16 and 17 are served by one container crane (31 metric ton) and are also leased by automobile importers (Jane's, 1992; AAPA, 1993 and 1994; D&B, 1993; POB, 1993). The terminal is approximately 3.2 km (2 mi) from Route I-93, which is part of the Greater Boston Beltway, which then connects with I-95 and I-90 (the Massachusetts' Turnpike). Access to the terminal is via East and West Broadway, a busy South Boston thoroughfare running through an area of primarily small businesses with some old residential housing. Construction of the Third Harbor Tunnel/Seaport Access Road began in 1992 for better interstate access. The terminal is served by Conrail whose tracks are located outside and at the rear of the terminal.

Massport Marine Terminal: This is a 16 ha (40 acre) facility used for cruise ships and the discharge of automobiles (roll-on/roll-off) and bulk cargo. This terminal is about 1.6 km (1 mi) from I-93 via Northern Avenue (a truck route to the Boston Fish Pier) and other industrial users along the waterfront (Jane's, 1992; AAPA, 1993 and 1994; D&B, 1993; POB, 1993).

Other Pertinent Information: Massport has its own security force, which has police powers at State-owned terminals. Although there is no officially designated space for segregating hazardous materials, the port would provide one if necessary. There are no known regulatory restrictions against handling of spent nuclear fuel at Massport terminals; the Deputy Port Director for Operations did not know if the port has ever handled spent nuclear fuel (Moriconi, 1993).

Massport relies on its fire department, which also has a fireboat, for emergency response for hazardous materials accidents, and on Coast Guard supervision. The port also coordinates its activities with State hazardous materials safety personnel. Massport has a training program for terminal workers at Moran, and recently began an introductory course for longshoremen. Training at leased facilities, like Moran Terminal, is the responsibility of the terminal operator (Moriconi, 1993).

Moran Container is located in the densely populated Charlestown area on the Mystic River across from petroleum and natural gas terminals, and a residential condominium/marina complex. Conley Terminal is in an industrial area with less conflicting use, but access is through South Boston, also a densely populated commercial/residential area.

There are no known special environmentally sensitive areas within the port. The likelihood of severe natural phenomena, such as high winds and earthquakes, is reflected in the structural requirements for buildings in each area of the United States. These are shown in the Uniform Building Code (UBC, 1991). For the Port of Boston, the Uniform Building Code requires buildings to withstand wind speeds up to 140 km/hr (85 mph). The port is located in a moderate seismic zone with an acceleration of 0.30 g.

The 1990 population within 16 km (10 mi) of the port terminals was 1,466,233. The affected populations within 0.8 km (0.5 mi) of the interstate routes to the five potential DOE management sites are: Savannah River Site, 1,080,000; Oak Ridge Reservation, 912,000; Idaho National Engineering Laboratory, 716,000; Hanford Site, 785,000; and Nevada Test Site, 796,000. Populations along rail routes to these sites are much larger. These populations are shown in Figures D-8 through D-17 in Section D.1. The distances to the five potential sites on interstate routes are: Savannah River Site, 1,734 km (1,079 mi); Oak Ridge Reservation, 1,600 km (995 mi); Idaho National Engineering Laboratory, 4,180 km (2,600 mi); Hanford Site, 4,850 km (3,016 mi); and Nevada Test Site, 4,560 km (2,832 mi). Distances along rail routes are about the same for Hanford Site and Idaho National Engineering Laboratory, and are slightly longer for Savannah River Site, Oak Ridge Reservation, and Nevada Test Site.

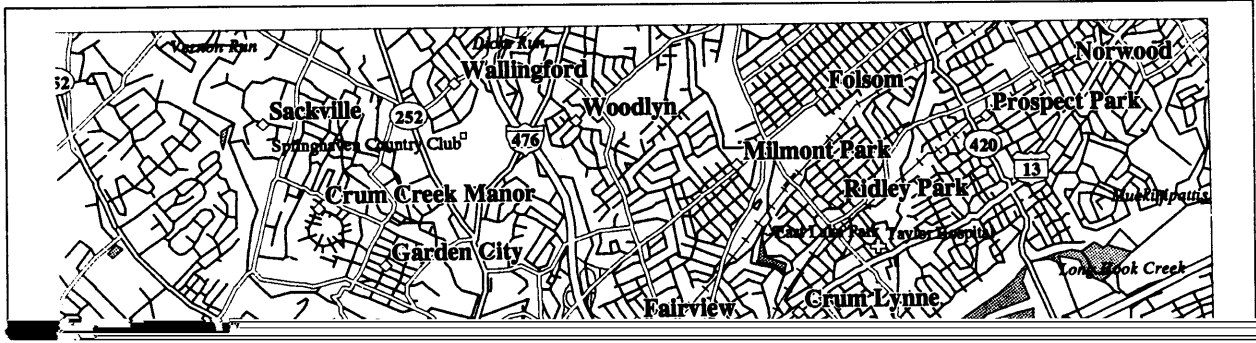
Climatic Conditions

Three important influences are responsible for the main features of Boston's climate (DOC, 1993a). First, the latitude 42°N places the city in the zone of prevailing west to east atmospheric flow, which encompasses the northward and southward movements of large bodies of air from tropical and polar regions. This results in variety and changeability of the weather elements. Secondly, Boston is situated on or near several tracks frequently followed by systems of low air pressure. The consequent fluctuations from fair to cloudy or stormy conditions reinforce the influence of the first factor, while also ensuring a rather dependable precipitation supply. The third factor, Boston's east coast location, is a moderating factor affecting temperature extremes of winter and summer.

Hot summer afternoons are frequently relieved by the locally celebrated "sea-breeze," as airflows inland from the cool water surface to displace the warm westerly current. This refreshing east wind is more commonly experienced along the shore than in the interior of the city or the western suburbs. In winter, under appropriate conditions, the severity of cold waves is reduced by the nearness of the then relatively warm water. The average date of the last occurrence of freezing temperature in spring is April 8; the latest is May 3, 1874 and 1882. The average date of the first occurrence of freezing temperature in autumn is November 7; the earliest on record is October 5, 1881. In suburban areas, especially away from the coast, these dates are later in spring and earlier in autumn by up to one month in the more susceptible localities.

Boston has no dry season. For most years the longest run of days with no measurable precipitation does not extend much more than two weeks. This "dry spell" may occur at any time of year.

Much of the rainfall from June to September comes from showers and thunderstorms. During the rest of the year, low-pressure systems pass more or less regularly and produce precipitation on an average of roughly one day in three. Coastal storms, or "northeasters," are prolific producers of rain and snow. The main snow season extends from December through March. The average number of days with four inches or more of snowfall is four per season, and the total snowfall is about 10 inches.



Penn Terminals was founded in 1986 to manage containerized cargoes but subsequently expanded its scope of services to include breakbulk and project cargoes. Penn Terminals' brochure states that they handle about 250 ship calls a year (PT, 1994). A port official reported that the Terminal handles 30,000 to 50,000 20-ft equivalent units a year, including some hazardous and radioactive materials (Davis, 1994). According to the Sandia National Laboratory's Radioactive Materials Postnotification (RAMPOST) Database, on April 17, 1991, this port was used for receipt of about 1.4×10^{16} Bq [366,000 curies (Ci)] of cobalt-60 for shipment to Dickerson, MD, in a Type B cask comparable to those used for spent nuclear fuel shipments (SNL, 1994). There was no indication of foreign research reactor spent nuclear fuel receipts since October 1984, when the database was established.

The Terminal features 40.7 ha (71 acres) of storage area, including 23,200 m² (250,000 ft²) of covered storage. The terminal has 335 m (1,100 ft) of marginal wharf, container gantry cranes, a 27 metric ton (30 ton) and a 41 metric ton (45 ton) and a heavy lift truck crane with a capacity of 220 metric tons (240 tons). Rail service is provided by Conrail. Access to Interstate 95 is about 1.6 km (1.0 mi) from the terminal via industrial and old residential streets (PT, 1994; AAPA, 1994).

The likelihood of severe natural phenomena, such as high winds and earthquakes, is reflected in the structural requirements for buildings in each area of the United States. These are shown in the Uniform Building Code (UBC, 1991). For the Port of Eddystone, the Uniform Building Code requires buildings to withstand wind speeds up to 130 km/hr (80 mph). The port is located in a low seismic zone with an acceleration of 0.075 g.

The 1990 population within 16 km (10 mi) of the port terminals was 609,241. The affected populations within 0.8 km (0.5 mi) of the interstate routes to the five potential DOE management sites are: Savannah River Site, 400,000; Oak Ridge Reservation, 300,000; Idaho National Engineering Laboratory, 600,000; Hanford Site, 600,000; and Nevada Test Site, 700,000. Populations along rail routes to these sites are slightly larger. These populations are shown in Tables D-7 through D-16 in Section D.1. The distances to the five potential sites on interstate routes are: Savannah River Site, 1,170 km (725 mi); Oak Ridge Reservation, 1,060 km (660 mi); Idaho National Engineering Laboratory, 3,930 km (2,440 mi); Hanford Site, 4,590 km (2,850 mi); and Nevada Test Site, 4,180 km (2,600 mi). Distances along rail routes are about the same.

Environmental Conditions

Monds Island and Chester Island are directly across the shipping channel from the port, and Little Tinicum Island is 1.8 km (1.1 mi) further. Tidal flats surround these islands, which are comprised of marshes and

wetlands. The Tinicum National Environmental Center, located approximately 3.5 km (2.2 mi) to the northeast on Darby Creek, is a nationally recognized wetlands and environmental education center.

The Port of Eddystone is located within Zone 4 (tidal river) of the Delaware River. Protected water uses for Zone 4, which encompasses River Miles (RM) 79-95, are water supply (industry), wildlife, resident fish maintenance, anadromous fish passage, secondary contact, and navigation (DRBC, 1994). However, several uses within Zone 4 are currently impacted, including: fish and other aquatic life due to low dissolved oxygen levels from point source discharges, and fish and shellfish consumption due to chlordane

(FWS, 1980f). In addition, the Delaware River is used as a migratory area by the shortnose sturgeon, a Federally listed endangered species. The Water Quality Section of the Pennsylvania Department of Environmental Resources reported that 67 species of fish are full or part-time residents of this part of the Delaware estuary (Boyer, 1994). Most importantly, the area of the river between Monds Island, Chester Island, and Little Tinicum Island and the islands' backwaters, is an important spawning site for the striped bass.

This area of the Delaware River serves as a sport fishery for striped bass, American shad, blue-claw crabs, white perch, largemouth bass, and catfish. There is also limited commercial fishing for American eels and American shad. There is only low to medium recreational use of this part of the Delaware River due to the high volume of tanker and freighter traffic (Boyer, 1994).

The U.S. Fish and Wildlife Service reported that except for occasional transient species, no Federally listed or proposed threatened or endangered species under their jurisdiction are known to exist in the port's impact area (Perry, 1994). Similarly, the Pennsylvania Natural Diversity Inventory reported that it did not expect any impact on rare, threatened, or endangered plant species in this location (PNDI, 1994).

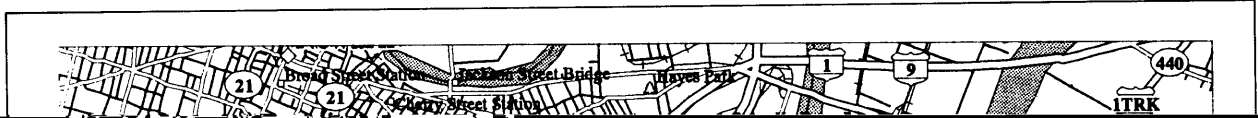
Climatic Conditions

The climate of the Eddystone region is similar to that of Philadelphia, PA. The area is moderated by the Appalachian Mountains to the west and the Atlantic Ocean to the east. These geographic features cause periods of extreme temperatures to be short-lived in this region (generally, four days). On occasion during the summer months, the area is dominated by maritime tropical air masses, which contribute to elevated local temperature and humidity levels. The average annual precipitation of 105.2 cm (41.42 in) is relatively evenly distributed throughout the year; with maximum amounts occurring during the late summer months. The summer precipitation regime is dominated by localized thunderstorms and are subject to the influence of the urban heat island effect and local topography, which create varying rainfall amounts across the city for an individual event. Singular snowfall events that generate accumulated totals of greater than 25.4 cm (10 in) have a 5-year recurrence interval on average. The prevailing wind direction has a bimodal distribution, being southwesterly during summer and northwesterly in the winter months. The annualized average prevailing wind direction is from the west-southwest. Due to this region's inland location, destructive winds are comparatively rare from tropical cyclones and tornadoes. High winds are generally associated with frontal passages/low pressure systems and thunderstorms in the winter and summer months, respectively. However, flooding on the Schuylkill River normally occurs twice annually, usually associated with strong thunderstorms, with the duration of these events generally lasting less than 12 hrs. The Delaware River is rarely observed at or above flood stage (NOAA, 1992h).

D.2.2.4 Elizabeth, NJ

New York Harbor is the principal entrance by water to New York City and the surrounding ports. The harbor is divided by the Verrazano Narrows into the Lower Bay and Upper Bay. Using the Verrazano Narrows Bridge as a reference point, Port Elizabeth is approximately 18 km (11 mi) from the Lower Bay and the Atlantic Ocean via Kill Van Kull. The Battery, the southern tip of Manhattan, is at the junction of the East River and Hudson River. New York Harbor includes New York City, Staten Island, and the New Jersey principal ports of Perth Amboy, Port Elizabeth, Port Newark, and Bayonne. The project depth of the channels leading from the sea through the Lower Bay, Narrows and Upper Bay is 13.7 m (45 ft). Depths in the Kill Van Kull leading to the New Jersey container terminals is 10.7 m (35 ft). The approaches to New York Harbor are open, but highly trafficked. The 13 km (8 mi) down the Kill Van Kull to Port Elizabeth is restricted (DOC, 1993b). A map of the port is provided in Figure D-35.

SELECTION AND EVALUATION OF POTENTIAL PORTS OF ENTRY



A P P E N D I X D

Unlike many ports of the world, no single governmental or public agency in New York is responsible for controlling the overall operation of the port. Port administration is divided among many organizations

The Kill Van Kull waterway, serving Port Elizabeth/Newark terminals, is also the approach route to the refineries and petroleum storage depots located along the Arthur Kill to the south. There is a great diversity of traffic and cargoes in the harbor but, due to the layout of the terminals, this diversity and traffic are not considered a major concern.

The Coast Guard and fire departments from the cities of Elizabeth and Newark, respond to hazardous materials incidents within terminals located within their municipalities. The Union County hazardous materials team responds to accidents in Port Elizabeth, and the Newark hazardous materials team in Port Newark. Sea-Land and other terminal operators have contracts with private companies for oil and chemical spill cleanup and/or decontamination work. It is not known what type of hazardous materials training is provided by terminal operators and/or the Port Authority (Hennessy, 1993). Training normally is provided in such large port operations. This was not investigated further because the port was not included in the final list selected for detailed assessment due to the extremely large populations around the port.

The Port Elizabeth/Newark terminals are separated from the urban city centers bearing their names. However, both are adjacent to Newark Airport and areas of heavy industrialization and heavy traffic on the Turnpike. There are also areas of dense population on the east side of Newark Bay in the cities of Bayonne and Jersey City. The 1990 population within 16 km (10 mi) of the port terminals was 3,223,038. The affected populations within 0.8 km (0.5 mi) of the interstate routes to the five potential DOE management sites are: Savannah River Site, 316,000; Oak Ridge Reservation, 290,000; Idaho National

blowing onshore from the cool water surface often moderate the afternoon heat; and most often in winter, coastal storms, accompanied by easterly winds, produce, on occasion, considerable amounts of precipitation.

From November through April the prevailing winds are from the northwest; for the remainder of the year the prevailing winds are southwesterly. Gales with velocities of 64 km/hr (40 mph) or more are predominantly from the northwest.

The mean annual temperature is slightly higher than that of most places in the United States of the same latitude, with the exception of localities near the Pacific coast. Precipitation is both moderate and distributed evenly throughout the year. Most of the rainfall from June through September comes from thunderstorms, therefore, is usually of brief duration, but relatively intense. From October to April, however, precipitation is generally associated with widespread storm areas, so that day-long rain or snow is common. Over the entire year, the city receives 59 percent of the sunshine hours possible at its latitude. This value compares favorably with that for any region east of the Mississippi, except the Southeast. Relative humidity averages about 66 percent for the year, showing that the city has a relatively damp climate.

Winds play an important role by affecting currents in the harbor. During the winter, west and northwest winds prevail, with northerlies and southwesterlies in secondary roles. The strongest winds are out of the west through northwest at 13 to 15 knots, from January through April. The sheltering effect of the land is apparent when looking at frequencies of winds of 28 knots or more. These winds blow at Ambrose Light about eight to nine percent of the time compared to one percent at Kennedy Airport and Floyd Bennet Field. Summer winds are often out of the south and southwest with a 10 to 12 knot afternoon peak. Fog in the harbor area is more closely related to land-type fogs. In winter, fog is common on clear, calm mornings and more frequent than at Ambrose Light. Southerlies can also bring winter fogs of the advection type. During the spring and early summer, the harbor and its approaches are susceptible to advection fog, riding in on east through south winds. A morning peak still exists in the harbor, while Ambrose Light exhibits an afternoon maximum (DOC, 1993b).

D.2.2.5 Fernandina Beach, FL

The Port of Fernandina is located about 9.3 km (5 mi) above the Entrance Seabuoy to the St. Marys River and Cumberland Sound. The entrance is bordered by two jetties on the approach to the cities of Fernandina Beach (located on Amelia Island) and St. Marys, GA, the Naval Submarine Base in Kings Bay, and an inland passage to St. Andrew sound via the Cumberland River (DOC, 1993d). The entrance is approximately 37 km (20 mi) north of the entrance to the Port of Jacksonville, which is located on the St. Johns River. A map of the port is shown in Figure D-36. Amelia Island is a small, historic, coastal resort town. Fort Clinch, a State Park, museum, and recreation area is located on the north end of Amelia Island at the inshore end of the south entrance jetty (DOC, 1993d).

The Port of Fernandina is a forest products and general cargo container port. It handles around 25,000 20-ft equivalent units of containerized freight and about 272,000 metric tons (299,000 tons) of forest products annually, but the container volume has varied considerably from year to year. Much of the port's trade is with South and Central America. There is also eastbound monthly service to the Mediterranean (Southern Shipper, 1993; American Shipper, 1994; Stubbs, 1994). Reportedly, the current controlling depth of the entrance and that of approach channel to the submarine base is 14.3 m (47 ft) and

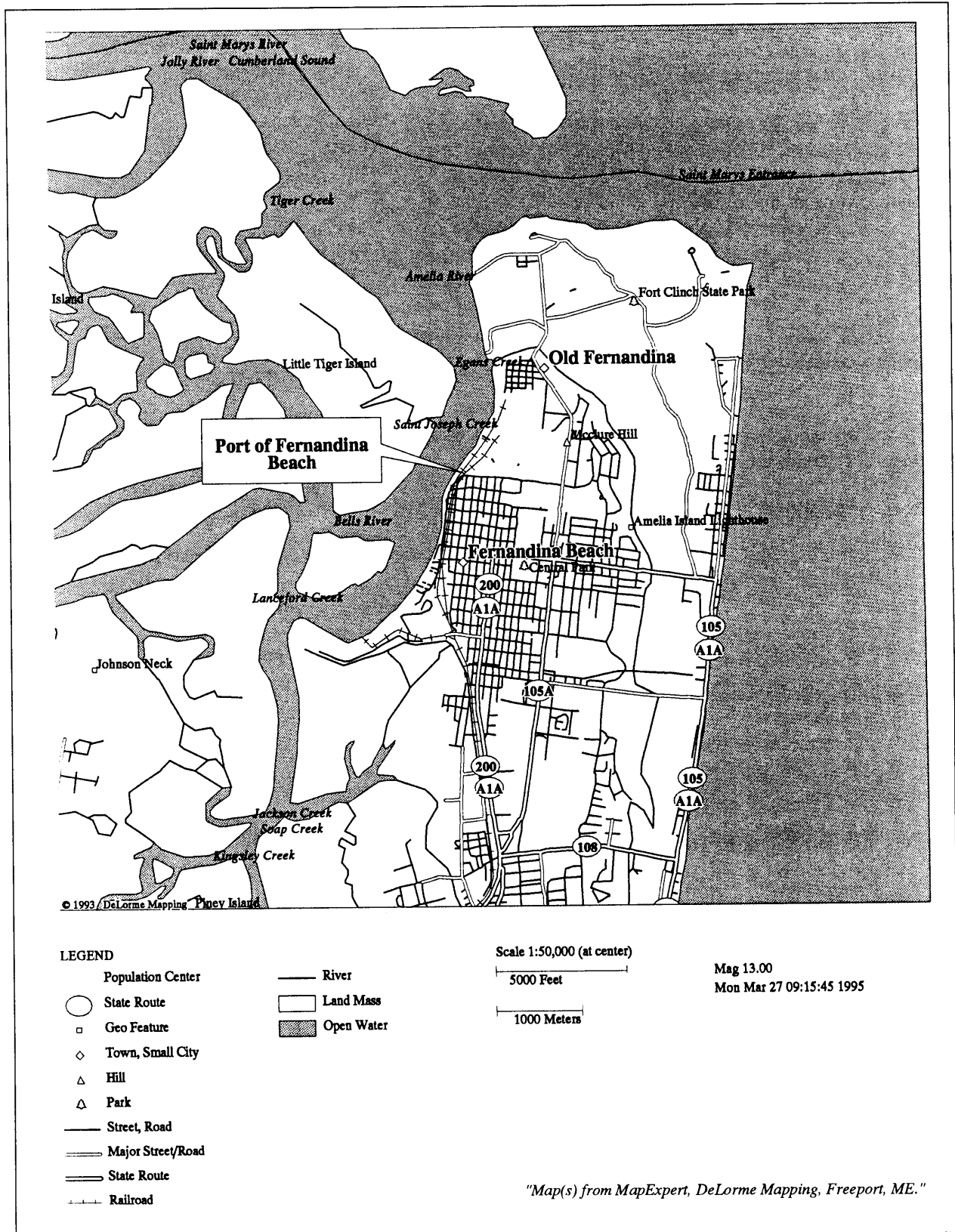


Figure D-36 Map of the Port of Fernandina Beach, FL

range of tide at Fernandina Beach. Tidal currents at the entrance have considerable velocity and are dangerous at times. A strong current "set" occurs at the St. Mary's entrance under certain weather conditions, it has been reported as high as 2.6 mi-per-sec (5 knots) (DOC, 1993d).

The Forest Products Terminal, located about 12 km (8 mi) above the channel entrance, is a publicly owned facility operated by Nassau Terminals, a private terminal operating and stevedoring company. Following a port expansion in 1992, the Terminal consists of 366 m (1,200 ft) of useable berthing situated on the left ascending bank of the Amelia River. The new capacity of the port is about 50,000 20-ft equivalent units per year. The Terminal is equipped with two 36 metric ton (40 ton) container cranes and other container handling equipment, a 4,645 m² (50,000 ft²) container freight station, 2.0 ha (5 acres) of open storage area, and is served by the CSX Railroad with pierside rail trackage (DOC, 1993d; Southern Shipper, 1993). The port handles an average of two vessels a day, typically a cruise vessel and a cargo vessel. The only products normally handled by the port are forest products for a paper mill located in the area, and containers loaded with food and paper products. The passenger or cruise ship business is small, using smaller vessels for cruises in the near islands and offshore (Robas, 1994).

The port terminal is located in the downtown section of the town of Fernandina Beach. Truck access to the port is through the downtown area and mixed residential/business structures for a distance of about 8 km (5 mi). Total distance to Interstate 95 is about 24 km (15 mi), much of which is divided multi-lane highway of mostly rural character.

Other Pertinent Port Information: Terminal property is fenced and lighted and has 24-hour watchman service. Rail openings into the port are not secured. The port has little experience in handling hazardous materials, in that hazardous materials are not normally shipped in or out of the port (Robas, 1994).

The U.S. Army Corps of Engineers was to award a contract in October 1994 for deepening the harbor channel to 11 m (36 ft) and constructing a 366 m (1,200 ft) turning basin. The approach channel to the Terminal passes through a State aquatic preserve for the manatee and other marine animals. Nassau Terminals occasionally handles some containerized hazardous materials; however, a port official thought there would be considerable local opposition to handling spent nuclear fuel shipments for fear of the effect of adverse publicity on tourism in this popular resort area (Stubbs, 1994).

The likelihood of severe natural phenomena, such as high winds and earthquakes, is reflected in the structural requirements for buildings in each area of the United States. These are shown in the Uniform Building Code (UBC, 1991). For the Port of Fernandina Beach, the Uniform Building Code requires buildings to withstand wind speeds up to 150 km/hr (95 mph). The port is located in a low seismic zone

The 1990 population within 16 km (10 mi) of the port terminals was 32,952. The affected populations within 0.8 km (0.5 mi) of the interstate routes to the five potential DOE management sites are: Savannah River Site, 45,000; Oak Ridge Reservation, 185,000; Idaho National Engineering Laboratory, 590,000; Hanford Site, 650,000; and Nevada Test Site, 650,000. Populations along rail routes to these sites are slightly larger. These populations are shown in Figures D-8 through D-17 in Section D.1. The distances

Environmental Conditions

The State of Florida has classified the Amelia River near the St. Mary's Entrance as a Class III water body. This classification indicates that the waters are suitable for recreation, and propagation and maintenance of a healthy, well balanced population of fish and wildlife (FL DEP, 1994). In addition, the State of Florida has designated certain waters in the vicinity of Fernandina Beach as "Outstanding Florida Waterways", which are afforded special protection. Outstanding Florida Waters are generally waters

~~that are subject to federal regulation, including marine sanctuaries or aquatic preserves.~~

D.2.2.6 Freeport, TX

Freeport harbor is located about 64 km (40 mi) southwest of the Galveston, Texas harbor entrance, and about 5 km (3 mi) from the Gulf of Mexico on the Brazos River (DOC, 1992a), with the Gulf Intracoastal Canal crossing the river, making deepwater activity available. The main channel is maintained at 13.6 m (45 ft) and leads to a 364 m (1,200 ft) turning basin (D&B, 1993). Freeport is principally involved in petroleum and petrochemical transport (AAPA, 1994). However, in 1992, 188,400 metric tons (207,711 tons) of containerized cargo (approximately 20,000 20-ft equivalent units) were handled in the port. Primary inbound cargoes were bananas and fruit, and primary outbound cargoes were rice and chemicals (AAPA, 1994).

The harbor is regulated by the Navigation and Canal Commissioners of the Brazos River Harbor Navigation District, and is known locally as Brazosport (DOC, 1992a). The ship channel has been improved by construction of jetties on either side of the entrance. A map of the port is shown in Figure D-37.

Berth assignments at the Port of Freeport are made by the Terminal Superintendent. The port has five general breakbulk berths, 664 m (2,190 ft) in length with 10.9 m (36 ft) depth alongside. There is 19 ha (47 acres) of open storage adjacent to the wharves (D&B, 1993). The port has rail facilities with dual tracks on Berths 1, 1A (Brazos Harbor Public Facility Wharf), and 2 (Brazos River Harbor Wharf No. 2). Both facilities have substantial covered storage available for short-term storage. General cargo is usually handled by the ship's tackle, and no container cranes are available at the port [a floating 450 metric ton (500-ton) derrick is available for heavy lifts by special arrangement] (DOC, 1992a; AAPA, 1994).

Highway connection from the port is via State Highways 227 and 288, for approximately 56 km (35 mi) to Houston, where Interstate-10 is accessed.

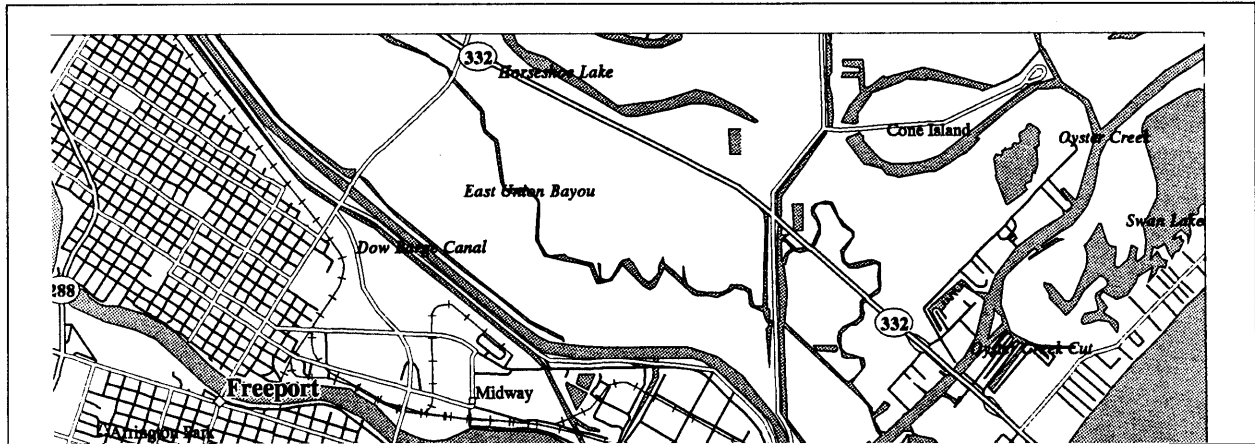
Other Pertinent Information: There are no known restrictions on receipt of foreign research reactor spent nuclear fuel at the port, but there are substantial conflicting activities at the port, including petrochemicals and hazardous chemicals (AAPA, 1994). The likelihood of severe natural phenomena, such as high winds and earthquakes, is reflected in the structural requirements for buildings in each area of the United States. These are shown in the Uniform Building Code (UBC, 1991). For the Port of Freeport, the Uniform Building Code requires buildings to withstand wind speeds up to 110 km/hr (100 mph). The port is located in a very low seismic zone with an acceleration of less than 0.075 g.

The 1990 census population of Freeport was 12,600. The affected populations within 0.8 km (0.5 mi) of the interstate routes to the five potential DOE management sites are: Savannah River Site, 360,000; Oak Ridge Reservation, 300,000; Idaho National Engineering Laboratory, 480,000; Hanford Site, 530,000; and Nevada Test Site, 530,000. Populations along rail routes to these sites are slightly higher for Savannah River Site and Oak Ridge Reservation, but slightly lower for Idaho National Engineering Laboratory, Hanford Site, and Nevada Test Site. The approximate distances to the five potential sites on interstate routes are: Savannah River Site, 1,600 km (1,000 mi); Oak Ridge Reservation, 1,600 km (1,000 mi); Idaho National Engineering Laboratory, 3,100 km (1,900 mi); Hanford Site, 3,700 km (2,300 mi); and Nevada Test Site, 3,100 km (1,900 mi). Distances along rail routes are about the same

Climatic Conditions

Weather in this area is only an occasional navigational problem. Winds blow at 28 knots (32 mph) or more approximately 3 to 4 percent of the time in November and from January through April. Average speeds are 12 to 14 knots (14 to 16 mph) during this period. Fog is also a winter problem, and visibilities drop below 160 m (0.25 mi) on approximately three to six days each month from November through April.

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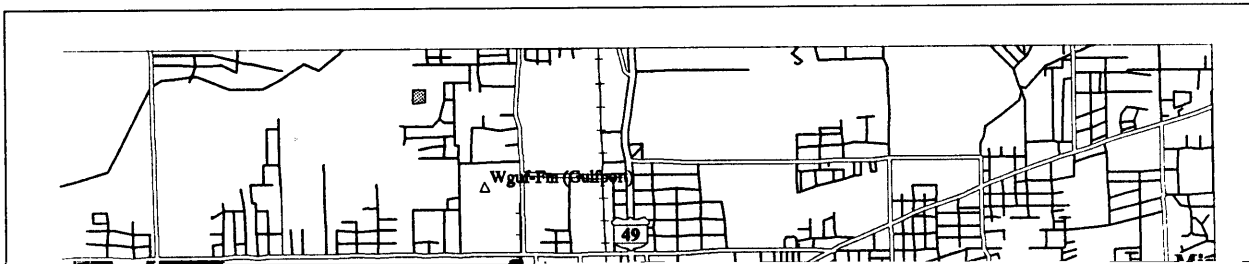


Thunderstorms are most frequent from April through September, during the afternoon and evening. These thunderstorms are usually air mass types as opposed to the less frequent but more severe thunderstorms that occur with fronts and squall lines from fall through spring. Tropical cyclones, particularly severe hurricanes, are most likely in August and September (DOC, 1992a).

D.2.2.7 Gulfport, MS

Gulfport, the seat of Harrison County, MS, is a seaport and tourist center located on the north side of Mississippi Sound, approximately 26 km (16 mi) from the entrance to the Ship Island Bar Channel on the Gulf of Mexico. Gulfport is located approximately 97 km (60 mi) east of New Orleans, LA. The approach to Gulfport is through a dredged channel marked by lighted buoys. Federal assistance for the

SELECTION AND EVALUATION OF POTENTIAL PORTS OF ENTRY



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the West Dock. As a result, the hazardous materials area at the north end of the West Dock has been eliminated for explosives. Also, the facility of particular hazard cannot be used for foreign research reactor spent nuclear fuel, and is not secure or well lit. (Brown, 1995)

There are no known sanctuaries or wildlife habitats in the immediate port area. However, to enter Gulfport, ships must pass close to the protected Gulf Islands National Seashore. The port is subject to severe hurricane and tropical storms. The likelihood of severe natural phenomena, such as high winds and earthquakes, are reflected in the structural requirements for buildings in each area of the United States. These are shown in the Uniform Building Code (UBC, 1991). For the Port of Gulfport, the Uniform Building Code requires buildings to withstand wind speeds up to 160 km/hr (100 mph). The port is located in a very low seismic zone with an acceleration of 0.075 g or less.

The 1990 population within 16 km (10 mi) of the port terminals was 113,153. The affected populations within 0.8 km (0.5 mi) of the interstate routes to the five potential DOE management sites are: Savannah River Site, 194,000; Oak Ridge Reservation, 146,000; Idaho National Engineering Laboratory, 435,000; Hanford Site, 484,000; and Nevada Test Site, 683,000. Populations along rail routes to these sites are slightly larger. These populations are shown in Tables D-7 through D-16 in Section D.1. The distances to the five potential sites on interstate routes are: Savannah River Site, 910 km (565 mi); Oak Ridge Reservation, 920 km (573 mi); Idaho National Engineering Laboratory, 3,570 km (2,219 mi); Hanford

typically found in the waters of this area include: shrimp, blue crab, seatrout, croaker, drum, spot, kingfish, flounder, catfish, mullet, Florida pompano, bluefish, Gulf menhaden, bay anchovy, Crevalle jack, blue runner, Alabama shad, and Atlantic bottlenose dolphin (FWS, 1982a).

Climatic Conditions

Because of Gulfport's geographic location, the local weather is greatly influenced by the Gulf of Mexico.

Generally, summers are warm but temperatures are more moderate than those observed at inland locations because of the diurnal sea breeze circulation. Winter weather is generally mild, with the exception of the occasional cold air outbreak. These events occur at 3-10 day intervals between October and April in the Gulf of Mexico region, generally lasting less than three days. The annual rainfall in this region is among the highest in the continental United States. The precipitation is fairly evenly distributed throughout the

A detailed street map of the Port of Houston area. The map shows a network of roads, including major highways I-10, I-610, and I-90A. Several parks are labeled: Klein, Northshore, White, Jacinto City, North, Pleasant Woods, Magnolia, Galena, and Clinton. Other landmarks include the Executive Golf Club and Country Club. A large white box with the text 'Port of Houston' is centered over the map.

has depths of 12.2 m (40 ft) at mean low water. Crane capacity for Barbours Cut Container Terminal is six 40.6 metric ton (45 ton) container cranes and two 30.5 metric ton (34 ton) container cranes (Jane's, 1992; AAPA, 1993).

Turning Basin Terminal: This terminal has several berths, the largest of which is 243.8 m (800 ft) long and can handle a 228.6 m (750 ft) ship. Turning Basin Terminal's depths are 10.97 m (36 ft) at mean low water. Crane capacity for this terminal is one 40.6 metric ton (45 ton) container crane and one 76.2 metric ton stiff-leg crane.

Barbours Cut Container Terminal has three entry points (gates) with a total of 21 truck lanes that are reached via Barbours Cut Boulevard, a multi-lane limited access roadway. Access to I-610, the Houston Beltway, and other interstate highways is via State Highway 146, which connects with State Highway 225 about 4.8 km (3 mi) from the Terminal. The Route 225 connector is an east-west highway about 22.5 km (14 mi) long. It appears that these routes run through commercial/residential areas with the opportunity for congestion. Barbours Cut Container Terminal is served by the Port Terminal Railroad Association and the Santa Fe Railroad. The Railroad Association connects with all other railroads including the Southern Pacific, Union Pacific, Burlington Northern, and the Houston Belt and Terminal Railroad. Trailer-on-Flat-Car shipments are possible within the terminal, but trackage does not extend to the container berths (Jane's, 1992; AAPA, 1993).

Barbours Cut Container Terminal is host to a large number of major international container and roll-on/roll-off ship lines. A partial listing includes: ABC Container Line, A. Bottacchi, ACL/Gulf Container Line, Afram Lines Ltd, America/Africa/ Europe Line, Atlantic Cargo Services, Baltic Shipping Co., Bank Line, Barber Blue Sea, CGM, CNAN, Columbus Line, COSCO, Costa Container Service, DB Turkish Cargo Line, Djakarta Lloyd, East Asiatic Ltd, Ellerman Line, Farrell Lines, Gulf Mideast Lines, Hapag-Lloyd, Hoegh Lines, Hyundai Merchant Marine, Italian Line, Ivaran Lines, Jugolinija, Kingwood Container Line, Maersk Line, Mediterranean Shipping Company, Nedlloyd Lines, SafBank Line, Sea-Land, Shipping Corp of India, Delmas-Vieljeux, Spanish Line, Torm Lines, Trans Freight Lines, United Arab Shipping Co., Waterman-Isthmian Line, and Zim Line (Jane's, 1992, AAPA, 1993).

Other Pertinent Information: The Houston Port Authority has its own 24-hour security force and all of its terminals are fenced with controlled access. A fireboat is stationed at Barbours Cut Container Terminal, which also has a full-service fire department. There is space within Barbours Cut Container Terminal for temporary segregation of hazardous cargoes (Horan, 1993).

A Port Authority Official was unaware of any regulations prohibiting the importation of spent nuclear fuel. The Houston Port Authority handles a lot of hazardous cargoes including radioactive substances, but the official did not know if the port has ever handled spent nuclear fuel (Horan, 1993). Available data indicates the port has not handled spent nuclear fuel at least since 1979 (NRC, 1993; SNL, 1994). The Houston Ship Channel and Galveston Bay are host to many petroleum and petrochemical berths and terminals served by a large amount of tanker and tank barge traffic. Many of these facilities are located upstream of Barbours Cut Container Terminal, which does not appear to have any conflicting use within its boundaries. The Houston Port Authority has its own emergency response team and fire department. The Houston Fire Department's hazardous materials team is used as a backup in emergencies. The Houston Port Authority has a hazardous materials training program for its terminal operating personnel. It is not known if longshoremen also receive this training (Horan, 1993).

There have been a number of ship accidents, tanker fires, and pipeline accidents at facilities near the Port of Houston in recent years. The United States Coast Guard data indicates that for the period 1991 to 1993, there were about 7,100 ship transits of the channel that resulted in 32 collisions, 33 allisions, 5 ship fires,

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and 59 hard groundings (USCG, 1994b). Because the accident statistics also reflect barge traffic risks, the accident rate for oceangoing vessels is probably lower, but there is not data to refine that estimate available yet.

The Turning Basin Terminal is located at the terminus of the Ship Channel in a densely populated area above all other public and private terminal facilities within the port. Barbours Cut Container Terminal is

located just upstream from other terminals and traffic

Records of sky cover for daylight hours indicate about one-fourth of the days per year as clear with maximum of clear days in October. Cloudy days are relatively frequent from November to May, and partly cloudy days are more frequent from June through September.

Snow rarely occurs; however, on February 14-15, 1895, 51 cm (20 in) of unmelted snow was measured. Heavy fog occurs on an average of 16 days a year, and light fog occurs about 62 days a year in the city, but the frequency of heavy fog is considerably higher at William P. Hobby Airport. Destructive windstorms are fairly infrequent, but both thundersqualls and tropical storms occasionally pass through the area (DOC, 1992d).

D.2.2.9 Lake Charles, LA

The city of Lake Charles, the seat of Calcasieu Parish, is located on the east side of the Lake. It is the center of large industries such as chemical, petroleum, natural gas, fish oil, synthetic rubber, salt, seafood, and rice. The Port of Lake Charles is situated 3 km (2 mi) south of the city on the east bank of the Calcasieu Lake, and is 52 km (32 mi) from the Gulf of Mexico (DOC, 1992a). A map of the port is shown in Figure D-40.

A Federal project provides for a channel 12.8 m (42 ft) deep across the outer bar, from 12.2 to 12.8 m (40 to 42 ft) through the jetties, and 12.2 m (40 ft) to the Port of Lake Charles.

The United States Coast Pilot (DOC, 1992a) reports: "In recent years a substantial number of oceangoing vessels of increased size and draft have been entering the Calcasieu River Channel and proceeding to and from berths as far up the channel as the Port of Lake Charles. The channel, however, has not been appreciably widened in recent years. Based upon reported marine casualties to vessels and upon reported navigational problems arising from the increased oceangoing traffic, and after consultation with local marine interests, the Coast Guard Captain of the Port (COTP) has developed certain guidelines to enhance safe navigation."

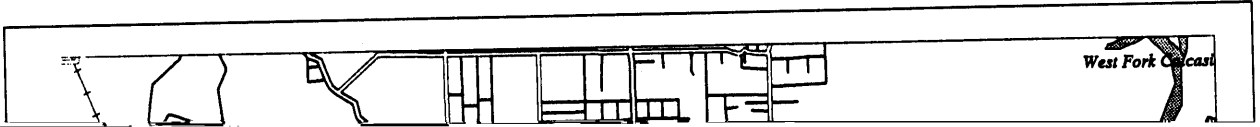
The longest berth in the terminal is 274 m (900 ft). Lake Charles has no international container carriers serving the port and serves primarily as a breakbulk, dry bulk, and project cargo niche port (AAPA, 1993 and 1994; Southern Shipper, 1993). It can handle limited container traffic on breakbulk vessels (about 30,000 20-ft equivalent units in 1992) (Southern Shipper, 1993). Most of the area around Calcasieu Lake is wetlands, and ships entering the port pass by the Sabine National Wildlife Refuge.

Like all Gulf Coast ports, it is subject to severe hurricanes and tropical storms. The likelihood of severe natural phenomena such as high winds and earthquakes is reflected in the structural requirements for buildings in each area of the United States. These are shown in the Uniform Building Code (UBC, 1991). For the Port of Lake Charles, the Uniform Building Code requires buildings to withstand wind speeds up to 160 km/hr (100 mph). The port is located in a very low seismic zone with an acceleration of less than 0.075 g.

Lake Charles, LA's climatic and environmental conditions are similar to those of the Port of New Orleans, LA. Port of New Orleans information is presented in Section D.2.2.14.

The 1990 census population estimate for this port vicinity was approximately 73,800 with a population density on the order of 940 persons/km² (2,434 persons/mi²). The approximate distances to the five potential sites on interstate routes are: Savannah River Site, 1,100 km (700 mi); Oak Ridge Reservation, 960 km (600 mi); Idaho National Engineering Laboratory, 3,400 km (2,100 mi); Hanford Site, 4,000 km (2,500 mi); and Nevada Test Site, 3,200 km (2,000 mi). Distances along rail routes are about the same.

APPENDIX D



D.2.2.10 Long Beach, CA

Long Beach and Los Angeles Harbors, although divided by a political boundary, form a single geographic and economic port entity. The harbors occupy a major part of San Pedro Bay. The Port of Long Beach, one of the largest ports on the Pacific Coast, has extensive foreign and domestic traffic with modern facilities for the largest vessels. Most of the channels in Long Beach Harbor are maintained at more than the project depth of 10.7 m (35 ft). The entrance to Middle Harbor is 3.5 km (2.2 mi) from the Queens Gate entrance at the Pacific Ocean. The channel from the Pacific Ocean is straight, short, and direct (DOC, 1992b). A map of the port is shown in Figure D-41.

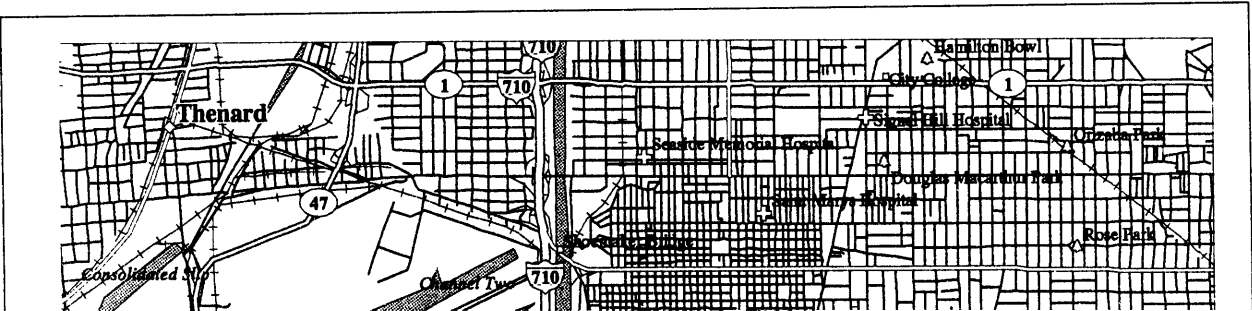
The Long Beach Harbor Department is a semi-autonomous agency of the City of Long Beach, CA. The Department is responsible for the operation, control, and development of the municipally owned port facilities. Long Beach is a large port (a load center) with 1,040 ha (2,816 acres) of land area, 12 piers, and 77 operational berths serving about 5,700 vessels annually. The port handles about 75 million metric tons (83 million tons) of revenue cargo annually, of which approximately 35 million metric tons (39 million tons) is containerized general cargo equivalent to 1.8 million 20-ft equivalent units (POLB, 1993a-d; AAPA, 1993).

Long Beach is a multi-terminal port and is host to seven container terminals with 38 container cranes and 243 ha (600 acres) devoted to container handling facilities. Additionally, there are facilities for petroleum and petroleum-related products, dry bulk materials, automobiles, steel, citrus, palletized general cargoes, and other commodities. The port functions as a "landlord" port leasing out its facilities to terminal and ship operating companies. Two of the container terminals (California United Terminals - Pier E, and Pacific Container Terminal - Pier J) are operated as "public" facilities. California United Terminals also has two roll-on/roll-off ramps and rail spurs (POLB, 1993a-d; AAPA, 1993; Janes's, 1992).

The dock/quay length available for cargo ships is as follows: California United, Pier E, Berths E24-E26 — 594 m (1,950 ft) long, and Pacific, Pier J, Berths J245-J247 — 1,006 m (3,300 ft) long. The corresponding depths alongside at mean low water are: California United with 14-15.2 m (46 to 50 ft), and Pacific Container with 14.9 m (49 ft). The five cranes at California United are all 40 metric ton (44 ton) container cranes. Pacific Container has six, 40 metric ton container cranes (Jane's 1992; AAPA, 1993; POLB, 1993a-d).

California United Terminals is served by an 11 lane main gate, which appears to be about 0.8 km (0.5 mi) from the "on" ramp to I-710 (the Long Beach Freeway), all within the confines of the port area. Pacific Container Terminal has similar ease of access to I-710, estimated to be a distance of about 1.9 km (1.2 mi)

APPENDIX D



Other Pertinent Information: Terminal operators are responsible for the security of their respective facilities. Container terminals are fenced with controlled access and the security forces are port employees (Powell et al., 1994). The port contracts with the City of Long Beach for police and fire protection services. The City of Long Beach stations two fireboats within the port area. There are locations within the terminals for temporary storage of hazardous materials (Hilliard, 1993) but no special areas set aside (Powell et al., 1994).

There are no known environmentally sensitive areas within the harbor area. However, the port claims a long-term interest in maintaining a high quality environment and supports a number of programs to prevent contamination of air and harbor water quality. It was the first recipient of the American Association of Port Authorities Environmental Improvement and Protection Award, and enforces strict safety policies as well. "In the past 50 years, there have been no collisions between commercial vessels resulting in injuries . . . and no significant oil spills from oil transfers." (POLB, 1993b).

The port Marketing Manager did not know of any regulation prohibiting the handling of spent nuclear fuel (Hilliard, 1993). According to available data, the port has not handled spent nuclear fuel since at least 1979 (NRC, 1993; SNL, 1994). The Port of Long Beach does handle other hazardous cargoes and has a number of deep-draft petroleum and petrochemical terminals.

the five potential sites on interstate routes are: Savannah River Site, 3,940 km (2,443 mi); Oak Ridge Reservation, 3,610 km (2,246 mi); Idaho National Engineering Laboratory, 1,580 km (979 mi); Hanford Site, 2,000 km (1,241 mi); and Nevada Test Site, 645 km (401 mi). Distances along rail routes are slightly longer.

Environmental Conditions

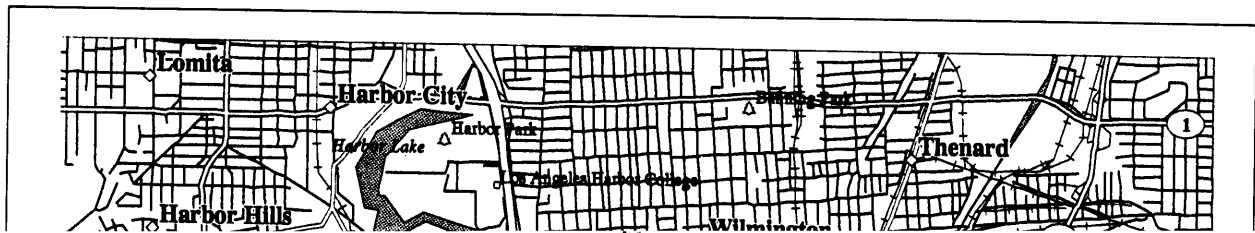
The environmental conditions for Long Beach are the same as those for Los Angeles. These are reported in Section D.2.2.11 below.

Climatic Conditions

Similar to the Los Angeles area, the climate of Long Beach, CA, is influenced significantly by the local topography. The Pacific Ocean has a moderating effect on the diurnal temperature range, which is greater than that observed further inland at the Los Angeles International Airport. In general, winter months are cool and wet followed by warm, dry summer months. Early morning clouds and fog, which are quite common during the late evening and early morning hours, generally burn off by late morning, resulting in sunny, pleasant daytime conditions during summer (NOAA, 1993f).

D.2.2.11 Los Angeles, CA

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Worldport LA Berths 142-146: Dock/Quay lengths are 853 m (2,800 ft) and depths alongside at mean low water are 10.67-11.3 m (35-37 ft) at mean low water. Worldport LA berths have crane capacities of three 40.6 metric ton (45 ton) container cranes (Jane's, 1992; AAPA, 1993).

RDP Terminal: Berths 174-181 have lengths of 1,006 m (3,300 ft) and depths of 10.67 m (35 ft) at mean low water. Capacity of RDP cranes is two 40.6 metric ton container cranes (Jane's, 1992; AAPA, 1993).

Indies Terminal: Berths 216-227 have total lengths of 1,128 m (3,700 ft) and depths of 13.72 m (45 ft) at mean low water. The Indies berths have three 40.6 metric ton (45 ton) container cranes (Jane's, 1992; AAPA, 1993).

Los Angeles terminals are served by the Harbor Freeway (I-110) and Terminal Island Freeway (Route 47) which connect with Interstate Highways 5, 10, 15, and 40. The Harbor Freeway begins within the Worldport LA port complex. Worldport LA is connected to the Southern Pacific Transportation Co., Union Pacific, and Santa Fe railroads by the Harbor Belt Line Railroad, jointly owned by the Los Angeles Harbor Department and the three railroads. Belt Line tracks extend to cargo ship berths at each of the Omni Terminals. Intermodal connections are presently made at the intermodal container transfer facility at the Port of Los Angeles, which is approximately 8 km (5 mi) away. A new intermodal

Director and U.S. Department of Transportation/Coast Guard Regulations are fully complied with (POLA, 1994). However, a spokesperson indicated that it was unlikely the port would accept spent nuclear fuel shipments (Verhoef et al., 1994).

The port police are the primary responders to hazardous materials incidents, backed up by the Los Angeles Fire Department and the United States Coast Guard. Based on Tariff Item 1715 referred to above, and the fact that radioactive shipments have occurred in the past, it is assumed port police have an adequate handling plan in place for radioactive materials. Worldport LA is an active participant in the Shoreline Emergency Network, a regional oil spill network organized to respond to coastal oil spill emergencies. The port police are trained in hazardous materials handling and are in charge of such operations. It is not known to what extent individual terminal operators are trained in hazardous materials response, but given the size and complexity of the port activities, it is assumed adequate hazardous materials training is provided. The combined ship accident history for the Ports of Long Beach and Los Angeles for the period of 1991-1993 is the lowest of all the major west coast ports (USCG, 1994b).

Worldport LA has a number of environmental programs underway that are designed to mitigate damage done to the marine environment in the past, and to prevent or lessen additional negative environmental impacts in the future. The port has a very active recreational/tourist component and, due in part to the presence of oil production facilities within the port, there is heightened environmental sensitivity on the part of the port community. The likelihood of severe natural phenomena such as high winds and earthquakes is reflected in the structural requirements for buildings in each area of the United States. These are shown in the Uniform Building Code (UBC, 1991). For the Port of Los Angeles, the Uniform Building Code requires buildings to withstand wind speeds up to 110 km/hr (70 mph). The port is located in a very high seismic zone with an acceleration of 0.45 g. Like most Southern California cities, the port is subject to severe earthquakes. Two relatively recent severe earthquakes in Southern California (along the San Andreas fault system along the Pacific and North American tectonic plates) occurred March 10, 1993, in Long Beach (Modified Mercalli Intensity IX) and February 9, 1971, in nearby San Fernando (Modified Mercalli Intensity VIII-XI). Both resulted in numerous deaths and injuries and caused massive structural damage to buildings.

The 1990 population within 16 km (10 mi) of the port terminals was 1,124,493. The affected populations within 0.8 km (0.5 mi) of the interstate routes to the five potential DOE management sites are: Savannah

The water quality of the harbor waters at the ports is generally considered good. Areas in the inner harbor with limited waterflow experience infrequent periods of poor water quality. There is a wider range of salinity in the inner harbor than in the outer harbor, with higher values at the bottom than at the surface (U.S. Army, 1990).

The waters of the Los Angeles-Long Beach Harbor contain a variety of marine habitats, some natural and some manmade. Numerous fish species use the habitats in the harbor, including several recreational (e.g., barred sand bass and white croaker) and commercial (e.g., anchovy and halibut) value, for all or part of their life cycle (U.S. Army, 1990). Commercial fishing operations for crabs and spiny lobsters also are in San Pedro Bay. Other sport-fishing in the bay includes flatfish, grunions, California halibut, white seabass, kelp bass, Pacific bonito, and Pacific barracuda (FWS, 1981c). Shallow waters are important nursery areas for several fish species. At least 60 species of water-associated birds use the harbor,

Climatic Conditions

The dominant geographic influences on the climate of the Los Angeles basin are the Pacific Ocean and the southern California coastal mountain ranges. Marine air covers the coastal plain for the majority of the year, but inland air does occasionally migrate into the region. Pronounced differences in temperature, humidity, cloudiness, fog, sunshine, and rain occur over fairly short distances along the coastal plain due to the local topography and the decreased effect of the marine environment further inland. However, in general, temperature ranges are least and humidity highest close to the coast, while precipitation increases with elevation in the foothills. Prevailing daytime winds are from the west, with nighttime and early morning winds generally light and from the east and northeast. During the fall, winter and spring months, dry, gusty northeasterly winds (e.g., Santa Ana winds) blow over the southern California mountains. Precipitation occurs mainly during the winter months. Thunderstorms are rare along the coast, but increase in frequency as one approaches the coastal ranges. Fog and low visibility are frequent problems for aircraft navigation at the Los Angeles International Airport (NOAA, 1993e).

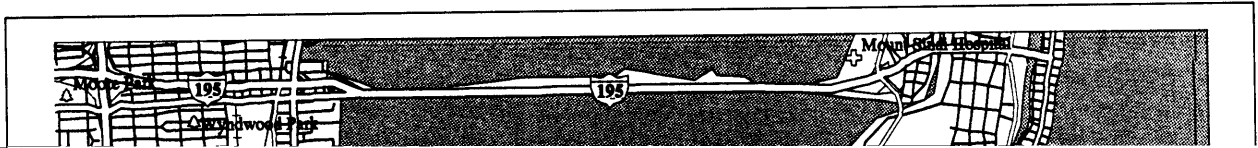
D.2.2.12 Miami, FL

Miami is Florida's most populous city and is located 8 km (5 mi) from the Gulf Stream on the east coast of Florida. It is an internationally famous winter resort and a popular yachting center. Miami is also a deepwater port; considerable foreign commerce passes through Miami and it is a major cruise port. Miami's cruise ship traffic has earned it the title of "Cruise Ship Capital of the World" (Southern Shipper, 1993). In addition to being a major shipping and cruise ship center, the Port of Miami is located in a popular resort area known for its beaches, fishing, recreational boating, and tropical landscape. The approach to Miami is open, but with strong tidal currents of 1.0 to 2.1 meters-per-sec (2 to 4 knots) in the entrance between the jetties. A Federal project provides for depths of 11 m (36 ft) to the main port facilities (DOC, 1993d; Southern Shipper, 1993; AAPA, 1993; Jane's, 1992). The port occupies 273 ha (675 acres) of land. It is situated on two interconnected islands, Dodge and Lummus, which lie in an east-west orientation due east of the City of Miami and west of the barrier island resort area of Miami Beach. The Miami Beach resort area forms the northern boundary of the harbor entrance. The major port facilities are within 5 km (3 mi) of the entrance from the Atlantic Ocean. A map of the port is shown in Figure D-43.

Miami's freight terminals serve as a hub for distribution and transshipment of cargo (largely tropical fruits and vegetables) to and from Latin America. The Port of Miami is an arm of the Dade County Seaport Department which functions as a "landlord" port. Almost 60 shiplines connect the port to most major countries in the world (Jane's, 1992; D&B, 1993; Southern Shipper, 1993). In 1994, nearly 520,000 20-ft equivalent-units were handled in the port (AAPA, 1994).

Lummus Island Terminal: The 91 ha (225 acre) terminal on the south side of the island is seaward of Dodge Island and just inside the entrance to the port. It is Miami's principal container handling facility with six container gantry cranes, including three new post-Panamax cranes and a new roll-on/roll-off berth. Activities at Dodge Island are primarily cruise ship, roll-on/roll-off, and breakbulk cargo oriented. Combined facilities consist of four container berths, 14 roll-on/roll-off berths, and 12 cruise ship berths. A private container terminal for shellfish is located on the north side of the island.

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noted as: Lummus Container Berths 1 and 2 with 12.8 m (42 ft) at mean low water. Berths 3 and 4 have 11.73 m (38.5 ft) at mean low water. On the north side of Dodge Island, the depth is 7.62-10.97 m (25-36 ft) at mean low water.

Crane capacities at Lummus Container Berths consist of three 50.8 metric ton (56 ton) container gantry cranes and three 40.6 metric ton (45 ton) container gantry cranes.

The Port of Miami is accessible via a five-lane, fixed bridge spanning the Intracoastal Waterway. It is approximately 1.2 km (0.75 mi) from the Biscayne Boulevard exit of I-395 to Dodge Island via NE 2nd Avenue in downtown Miami. I-395 is a connector to I-95 as well as all other south Florida highways. There are 5.2 km (3.2 mi) of trackage within the Port of Miami including a four-track marshalling yard. Rail connections are with the Florida East Coast and CSX Railroads.

Port of Miami

to the five potential sites on interstate routes are: Savannah River Site, 1,200 km (748 mi); Oak Ridge Reservation, 1,460 km (906 mi); Idaho National Engineering Laboratory, 4,570 km (2,842 mi); Hanford Site, 5,240 km (3,258 mi); and Nevada Test Site, 4,740 km (2,945 mi). Distances along rail routes are slightly longer, except for Savannah River Site, which is slightly less.

Environmental Conditions

The State of Florida has classified Biscayne Bay near Port of Miami as a Class III water body. This classification indicates that the waters are suitable for recreation, and propagation and maintenance of a healthy, well balanced population of fish and wildlife (FL DEP, 1994). In addition, the State of Florida has classified the Biscayne Bay, where the Port of Miami is located, as an "Outstanding Florida Water." As previously noted, Outstanding Florida Waters are generally waters located within national

parks, state parks, national seashores, marine sanctuaries, or aquatic preserves. Other waters located near Port Everglades that are designated as Outstanding Florida Waters include Biscayne Bay National Park and the Bill Bags State Recreation Area. These waterways are afforded special protection by State environmental regulations (FL DEP, 1994).

The Biscayne Bay, in the vicinity of the Port of Miami, is characterized as a high salinity estuarine habitat (waters less than 30 parts per thousand). There are both commercial and recreational fish and

months of September and October exhibiting the highest frequencies. However, destructive tornadoes (not associated with tropical systems) are rare. Waterspouts are frequently spotted offshore during the summer months, but rarely cause any loss of life or property damage (NOAA, 1993b).

D.2.2.13 Military Ocean Terminal, Oakland, CA

The Military Ocean Terminal, Bay Area, is located in the Outer Harbor of the Port of Oakland, adjacent to the east entrance to the Oakland Bay Bridge (descriptions of Oakland ship channels also apply to Military Ocean Terminal, Bay Area and are not repeated here). The facility is located approximately 16 km (10 mi) east of the Golden Gate Bridge, which spans the Pacific Ocean entrance to San Francisco Bay to the south and San Pablo Bay to the north. The single pier (Wharf 7) currently available for military cargo is directly opposite the commercial Sea-Land and Public Container Terminals, and located within the Oakland Army Base (MTMCTEA, 1990). The facility has the largest sealift workload of any military traffic ports on the West Coast, averaging on the order of 3,000 metric tons (3,300 tons) of cargo per year (the 1994 shipments of Patriot missiles to South Korea were shipped from Wharf 7). See the descriptions of the Port of Oakland for more information regarding truck and rail access, maps, populations, etc. A map of the terminal is shown in Figure D-44.

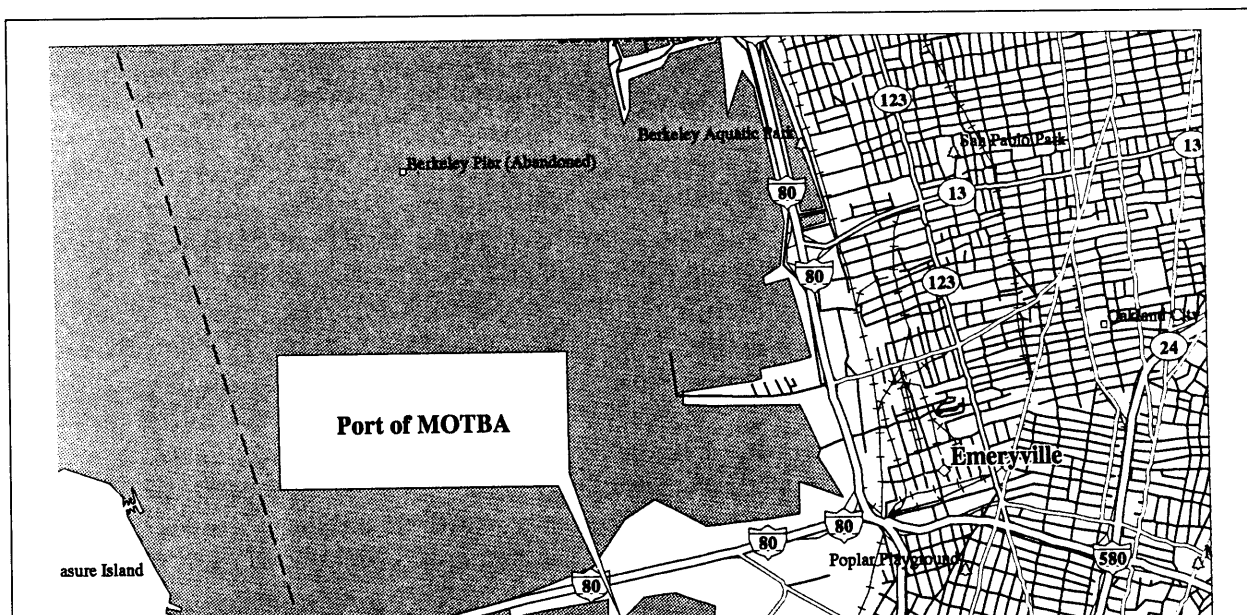
The Bay Bridge Terminal, adjacent to Military Ocean Terminal, Bay Area, operates Military Ocean Terminal, Bay Area wharves 6 and 6.5 as Berths 8 and 9 for its commercial operation (Jane's, 1992; MTMCTEA, 1990). Wharf 7 is 445 m (1,459 ft) long, with 10.6 m (35 ft) depth alongside. Wharf 7 has a single 91 metric ton gantry crane for all breakbulk operations and a container spreader that can be attached for limited container handling (MTMCTEA, 1990). A floating crane of comparable capacity is also available. Stern loading roll-on/roll-off operations are not feasible at the facility.

There are more than 8.1 ha (20 acres) of open storage space near the wharf, and a transit shed at the wharf provides more than 13,000 m² (141,000 ft²) of covered storage. More than 65,000 m² (700,000 ft²) of additional covered space is available on the Army Base (MTMCTEA, 1990).

Trucks can access the wharf for direct loading from ships at the facility. Access to Interstates 580, 680, or 880 is directly adjacent the Army Base through a largely industrial area at the Port of Oakland. Residential areas are within a few kilometers of the Base and the Port of Oakland.

The entire length of Wharf 7 is served by rail, making direct ship-to-rail loading possible for receipt of incoming cargo. Rail movements are carried out by two Base locomotives, which can move rail shipment to the adjacent and expanding Oakland Intermodal Terminal. The Intermodal Terminal is serviced by the Southern Pacific and Union Pacific rail systems and connections with the Atchison, Topeka, and Santa Fe Railroad intermodal yard about 19 km (12 mi) north of the port (MTMCTEA, 1990).

Other Pertinent Information: Since the facility is part of the Oakland Army Base, it is well lighted, fenced, and patrolled by gate guards and roving patrols. There are no full-time longshoremen at the



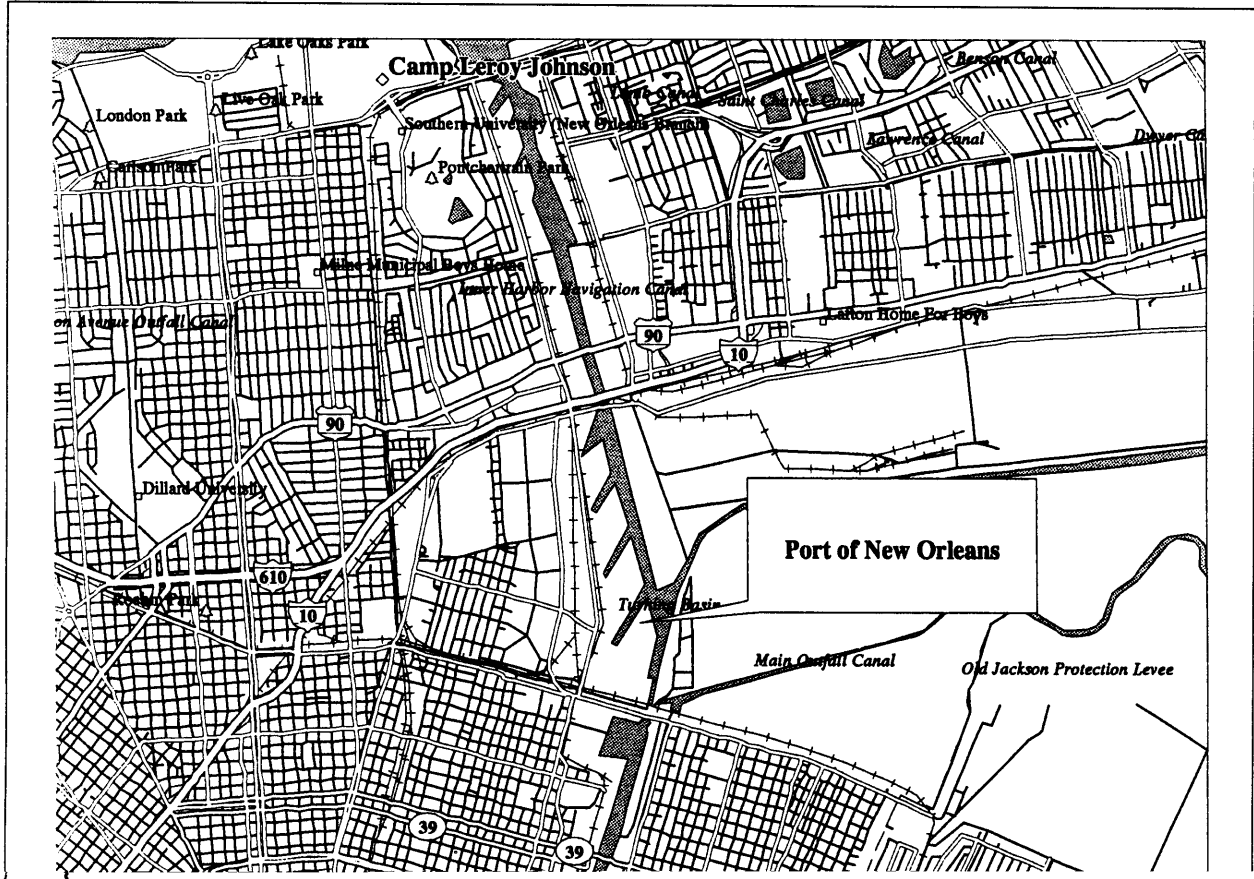
Area 1990 census population and density figures are 1,110,549 and 1,323 persons/km² (511 persons/mi²), respectively. The 1990 population within 16 km (10 mi) of the port terminals was 1,288,899. The affected populations within 0.8 km (0.5 mi) of the interstate routes to the five potential DOE management sites are: Savannah River Site, 1,080,000; Oak Ridge Reservation, 786,000; Idaho National Engineering Laboratory, 367,000; Hanford Site, 359,000; and Nevada Test Site, 482,000. Populations along rail routes to these sites are slightly larger. These populations are shown in Figures D-8 through D-17 in Section D.1. The distances to the five potential sites on interstate routes are: Savannah River Site, 4,216 km (2,791 mi); Oak Ridge Reservation, 4,121 km (2,563 mi); Idaho National Engineering Laboratory, 1,548 km (963 mi); Hanford Site, 1,407 km (875 mi); and Nevada Test Site, 1,156 km (719 mi). Distances along rail routes are slightly longer.

The Military Ocean Terminal, Bay Area, is located in the Outer Harbor of the Port of Oakland. Climatic and environmental conditions for Military Ocean Terminal, Bay Area are the same as those for the Port of Oakland. These are presented in Section D.2.2.15.

D.2.2.14 New Orleans, LA

The Port of New Orleans is one of the largest ports in the United States. It is located on both sides of the Mississippi River with its lower limit about 129 km (80 mi) above the Head of the Passes from the Gulf of Mexico, and its upper limit about 185 km (115 mi) above Head of the Passes. A Federal project provides for a channel 13.7 m (45 ft) deep over the bar through Southwest Pass to Head of the Passes, and on to New Orleans. The Port of New Orleans' lower limit is about 160 km (98 mi) from the Gulf of Mexico via Southwest Pass. Southwest Pass is straight and well marked, and is the only navigable channel between the Gulf of Mexico and the Mississippi River.

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at Berth 6. Berths 5 and 6 have a combined length of 518 m (1,700 ft) of marginal wharf with water depth alongside ranging from 9.75 - 10.97 m (32 - 36 ft) at mean low water (AAPA, 1993; Janes's, 1992; D&B, 1993; Southern Shipper, 1993; PON, 1994).

The France Road Public Container Terminal is located in a port industrial district that appears to be remote from residential areas and a considerable distance from the downtown New Orleans business

district. This terminal is about 2.4 km (1.5 mi) from Interstate Highway 10 and U.S. Route 90 — major east-west highways — via Alvar Street or Florida Avenue, which are heavy truck routes. I-10 connects with I-49 to Shreveport, where it meets I-20. The Terminal has good truck and rail access, but waterway access is via the relatively narrow industrial canal with a lock near the entrance and several bridges en route. The city-owned Public Belt Railroad connects the France Road and other terminals on the Mississippi, Industrial Canal, and Mississippi/Gulf Outlet with the CSX, Illinois Central, Kansas City Southern, Norfolk Southern, Southern and Union Pacific Railroads. In the case of France Road Terminal, the Belt Railroad tracks serve the site, but not the pier apron.

The Port of New Orleans is port-of-call for over 50 steamship lines providing breakbulk and container freight service to virtually all of the world's major port cities. A partial list of these lines includes ABC Container Line, Argentine Line, ART Ocean Line, Atlantic Container Line, Baltic Shipping, Bank Line

East Africa, Boss Line, China Ocean Shipping Co., Contship Container Line, Chilean Line, Daiichi-Chuo Shipping Line, Delmas/AAEL, Egyptian National, Forest Lines Inc., Hapag-Lloyd, Hoegh Line, Hyundai

1,065 hard groundings reported (see 46 CFR 4.05-1 for reporting requirements and definitions). The 2,680 accidents involved one of the following: vessel damage in excess of \$25,000 and/or left the vessel unseaworthy, or without power or steering, or severe injury or death. The port 1993-1994 Annual Directory indicates that during this period, there were about 7,100 vessel transits (PON, 1994). Since the accident statistics include barge accidents (and New Orleans has large barge traffic), this number is rather high for oceangoing vessels, but no data are yet available yet to refine the information.

Other than flooding from severe hurricanes and tropical storms, and general environmental concerns, there are no known special environmental or wildlife issues in or near the port area. The likelihood of severe natural phenomena such as high winds and earthquakes is reflected in the structural requirements for buildings in each area of the United States. These are shown in the Uniform Building Code (UBC, 1991). For the Port of New Orleans, the Uniform Building Code requires buildings to withstand wind speeds up to 160 km/hr (100 mph). The port is located in a very low seismic zone with an acceleration of less than 0.075 g.

The 1990 population within 16 km (10 mi) of the port terminals was 782,868. The affected populations within 0.8 km (0.5 mi) of the interstate routes to the five potential DOE management sites are: Savannah River Site, 266,000; Oak Ridge Reservation, 256,000; Idaho National Engineering Laboratory, 455,000; Hanford Site, 504,000; and Nevada Test Site, 687,000. Populations along rail routes to these sites are slightly smaller for Idaho National Engineering Laboratory, Hanford Site, and Nevada Test Site and much larger for Savannah River Site and Oak Ridge Reservation. The distances to the five potential sites on interstate routes are: Savannah River Site, 1,020 km (634 mi); Oak Ridge Reservation, 960 km (594 mi); Idaho National Engineering Laboratory, 3,510 km (2,184 mi); Hanford Site, 4,180 km (2,600 mi); and Nevada Test Site, 3,450 km (2,145 mi). Distances along rail routes are slightly longer.

Environmental Conditions

The State of Louisiana has classified the waters of the Industrial Canal and the Mississippi River Gulf Outlet as suitable for primary and secondary water recreational activities and the propagation of fish and wildlife. The Mississippi River supports all of these uses in addition to being used as a drinking water supply source (Fabens, 1994).

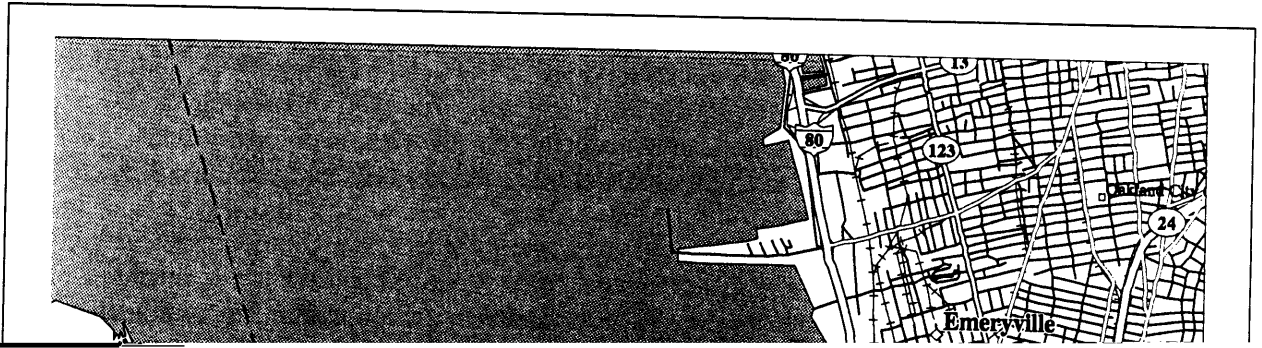
The Mississippi River Gulf Outlet, in the vicinity of the France Road Terminal, is characterized as a high salinity estuarine habitat (generally greater than 20 parts per thousand). The entire canal travels through marshlands. Aquatic species found in these types of marshlands and surrounding areas in Louisiana include: shrimp, blue crab, eastern oyster seatrout, Atlantic croaker, drum, spot, kingfish, sheepshead, flounder, mullet, sea catfish, gulf menhaden, bay anchovy, crevalle jack, and Atlantic bottlenose dolphin (FWS, 1982d).

As ships approach the Mississippi River Gulf Outlet from the north they must travel past the Breton National Wildlife Refuge and Breton Wilderness. Birds of interest in these areas include: peregrine falcon, brown pelican, shorebirds, wading birds, herons, egrets, white ibis, least bittern, gallinules, waterfowl, bird hawks, osprey, magnificent frigate-bird, white pelican, songbirds, warblers and diving ducks. The peregrine falcon and brown pelican are protected species. Aquatic species found in these areas include: loggerhead sea turtle, spotted sea trout, drum, bluefish, cobia, and mackerel. The loggerhead sea turtle is a Federally protected species (FWS, 1982d). Travelling north into the Mississippi Gulf River Outlet towards the France Road Terminal ships must pass near the Biloxi Wildlife Management area.

Climatic Conditions

The city of New Orleans is essentially surrounded by water. Thus, the influence of the Gulf of Mexico and the surrounding bayous, lakes, and marshes are significant. The climate can best be described as

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Crane capacities at Seventh Street Marine Containers Terminal include two 40.6 metric ton (45 ton) container cranes and one 30.5 metric ton (34 ton) container crane. Outer Harbor Public Container Terminal has crane capacity of two 40.6 metric ton (45 ton) container cranes (Jane's, 1992; AAPA, 1993).

Inner Harbor: The Charles Howard Terminal, Berths 67 - 69, has three container cranes, 19.8 ha (48.9 acres) of terminal area, and storage for over 3,000 20-ft equivalent units. Quay lengths at Charles Howard Terminal are as follows: two marginal wharves of 501 m each (1,642 ft) and one 173 m (568 ft) wharf. The Charles Howard Terminal has crane capacity consisting of two 40.6 metric ton (45 ton) container cranes and one 50.5 metric ton (56 ton) container crane (Jane's, 1992; AAPA, 1993).

Seventh Street Marine Containers Terminal, Outer Harbor Public Container Terminal, and Charles Howard Terminal have depths alongside at mean low water of 12.2 m (40 ft). Approach channels are currently limited to 10.6 m (35 ft). A dredging program to 12.8 m (42 ft) is scheduled for completion by 1995 (Jane's, 1992; AAPA, 1993).

Located just south of the Oakland Bay Bridge, the Port of Oakland has immediate access to Highway I-80 for shipments to Idaho National Engineering Laboratory and/or transcontinental shipments, and Highways I-580/I-5 for east coast shipments via the southern route I-40. The truck route from Seventh Street Marine Containers Terminal to the interstate appears to be almost entirely within the port complex in an area dedicated to cargo handling and shipping functions. The Port of Oakland is served by the Union Pacific, Southern Pacific, and Santa Fe Railroads (D&B, 1993). The port has an intermodal container transfer facility, but there does not appear to be direct rail service to container berths at the Seventh Street Marine Containers Terminal (Jane's, 1992; AAPA, 1993).

The Port of Oakland is served by many of the world's largest container lines, including American President Lines, Atlantic Container Lines, Australia-New Zealand Container Line, Cho Yang, DSR Senator Line, EAC Lines, Hanjin Shipping Co., Hapag-Lloyd, Hawaiian Marine, Hyundai, Italian Line, "K" Line, Maersk Lines, Matson Navigation Co., Mitsui OSK, Neptune Orient, NYK Lines, OOCL, Sea-Land Service, and Yang Ming Line (Jane's, 1992; AAPA, 1993; D&B, 1993). Four additional lines switched from San Francisco to Oakland in 1994 (Mitchell, 1994; Adams, 1994).

Other Pertinent Information: Security of the port is provided by perimeter fencing and unarmed guards from the International Longshoremen Union who maintain 24-hour patrol and surveillance (Adams, 1993; Adams and Renteria, 1994). Therefore, it is assumed that foreign research reactor spent nuclear fuel shippers using the port would have to provide their own security force.

The Port Commission has an active ban on the handling of spent nuclear fuel in recognition of community anti-nuclear sentiment which led to a citizens legislative initiative banning such shipments (subsequently struck down by a Federal court). The port handles radioactive and other hazardous materials shipments but officials did not know if Oakland has ever handled spent nuclear fuel shipments (Adams, 1993). The available data shows that Oakland has received spent nuclear fuel shipments, with the last shipment in 1988 (NRC, 1993).

Outer Harbor container and general cargo terminals are situated at the entrance to the port and there appears to be little or no conflict with other hazardous cargoes including petroleum products shipped through the port's breakbulk and liquid bulk terminals located within the Inner Harbor (Adams, 1993; Adams and Renteria, 1994).

Emergency response capability is the responsibility of the individual terminal operators. Each terminal operator must have an Emergency Contingency Plan approved by the Port Commission and the U.S. Coast Guard. The Oakland Fire Department has a hazardous materials response team, and the response time for

emergencies is about five minutes (Adams and Renteria, 1994). Beginning in November 1994, the port is increasing its emergency response capabilities. Financed by a new \$50 million bond, the port is adding a new fire station, an Emergency Operations Center, new fire boats, a completely equipped hazardous materials van, and a fire-fighting bucket to be lifted in by helicopter. The port also has agreements with neighboring cities (Berkeley, San Leandro, and Alameda) for emergency response (Adams and Renteria, 1994). It is the responsibility of individual terminal organizations and/or the port to provide hazardous materials instruction to the longshoremen (Adams, 1993; Adams and Renteria, 1994).

The Seventh Street Marine Containers Terminal is located in the Outer Harbor terminal complex seaward of the downtown Oakland business district, in an area primarily dedicated to port industrial usage with excellent connections to highways and rail service. However, the port is located in a large urban area in which congestions are to be expected. The San Francisco Bay Area has had only 31 collisions, but 21 fires were reported during the period 1991 to 1993—the worst fire record for major West Coast ports (USCG, 1994b).

There are no known areas of special environmental concern; however, there is strong concern for preservation of the environment, and this area is prone to severe earthquakes. On April 18, 1906, the Bay area was subjected to one of the largest recorded earthquakes in the contiguous United States, a Modified Mercalli Intensity XI (Bolt, 1978), due to movement along the fault line separating the Pacific and Continental tectonic plates (Hamilton, 1976). The likelihood of severe natural phenomena such as high winds and earthquakes is reflected in the structural requirements for buildings in each area of the United States. These are shown in the Uniform Building Code (UBC, 1991). For the Port of Oakland, the Uniform Building Code requires buildings to withstand wind speeds up to 110 km/hr (70 mph). Since the port is located in a very high seismic zone (the highest Uniform Building Code ranking), buildings must be constructed to withstand an acceleration of 0.40 g.

The 1990 population within 16 km (10 mi) of the preferred port terminals was 1,387,611. The affected populations within 0.8 km (0.5 mi) of the interstate routes to the five potential DOE management sites are: Savannah River Site, 1,080,000; Oak Ridge Reservation, 786,000; Idaho National Engineering Laboratory, 367,000; Hanford Site, 359,000; and Nevada Test Site, 482,000. Populations along rail routes to these sites are slightly larger for Savannah River Site, Hanford Site and Nevada Test Site, but slightly smaller for Oak Ridge Reservation and Idaho National Engineering Laboratory. These populations are shown in Figures D-8 through D-17 in Section D.1. The distances to the five potential sites on interstate routes are: Savannah River Site, 4,490 km (2,791 mi); Oak Ridge Reservation, 4,120 km (2,563 mi); Idaho National Engineering Laboratory, 1,550 km (963 mi); Hanford Site, 1,410 km (875 mi); and Nevada Test Site, 1,160 km (719 mi). Distances along rail routes are slightly longer.

Environmental Conditions

The area around the terminal includes the San Francisco Bay to the south and the San Pablo Bay to the north. The Farallon Islands Game Refuge and the Point Reyes-Farallon Islands National Marine Sanctuary lie along the passageway to San Francisco. The San Francisco Bay National Wildlife Refuge and the Redwood Shores Ecological Reserve, both within the San Francisco Bay, are located 33 and 30 km south (20 and 18 mi), respectively from the Port of Oakland. The San Pablo Bay National Wildlife Refuge is located approximately 160 km (99 mi) north of the port.

San Francisco Bay

The Central Bay portion of the San Francisco Bay has several usage classifications, including industrial process supply, industrial service supply, navigation, water contact recreation, noncontact water recreation, ocean commercial and sport fishing, wildlife habitat, preservation of rare and endangered species, fish migration, fish spawning, shellfish harvesting, and estuarine habitat (State of California, 1986).

The San Francisco Bay comprises the largest estuarine ecosystem in California. The estuary encompasses a range of aquatic habitats, from the fresh and brackish waters of the Sacramento-San Joaquin River Delta to the saline waters of the Central and South Bay. The estuary provides habitat for a variety of aquatic species, some of which are important to commercial and recreational fisheries. These waters serve as a nursery area for marine, anadromous, and estuarine species, and provide a migration corridor for several anadromous species. Striped bass, Chinook salmon, steelhead trout, sturgeon, American shad, and English sole support important recreational fisheries in the estuary. Popular recreational fisheries in the Delta also include white catfish, largemouth bass, and sunfish (U.S. Army, 1994). In addition, the area around the port has populations of the common littlenecked clam, the soft-shelled clam, striped bass and flatfish, the California clapper rail, and the salt-marsh harvest mouse (FWS, 1981b).

Historically, marshlands bordering the Bay covered some 300 mi²; diking for agriculture and filling for development has reduced the marshlands to about 75 mi² (U.S. Army, 1994). The marshes and mudflats remaining along the margins of the Bay are very productive and provide habitat for a large number of birds and other wildlife. For instance, the area around the port has populations of the California clapper rail and the salt-marsh harvest mouse (FWS, 1981b). The Bay is a key resting, feeding, and wintering area for birds on the Pacific Flyway. This area annually supports a large number of shorebirds, wintering waterfowl, raptors, seabirds, and passerines. Shorebirds, wading birds, waterfowl, seabirds, songbirds, and other species migrate through the entire coastal zone in the San Francisco area (FWS, 1981b).

Several threatened or endangered species are known to occur or have the potential to occur occasionally or periodically in the San Francisco Bay area. These species include the California least tern, California brown pelican, the American peregrine falcon, and the winter-run chinook salmon (U.S. Army, 1994). The least terns breed in California from mid-May to August and nesting colonies are located on open flat beaches, sand flats, and bare dirt areas with sparse vegetation. The least tern generally migrates from the Bay Area in August and winters south of the United States. The California brown pelican uses the open waters of the central San Francisco Bay for feeding; they roost on rocks, jetties, and piers in the area. Although no brown pelicans breed in the San Francisco area (Bay or offshore), thousands move north and roost on coastal rocks during the June through October nonbreeding season. Several thousand pelicans summer in the San Francisco area. The American peregrine falcon is considered rare in the region. It formerly bred on the Farallon Islands, and though it has yet to breed there again, winter residents have returned and have stabilized in number. The American peregrine falcon is most common to the San Francisco Bay area during the winter, when migrants from farther north concentrate in the estuary. The nesting season is from spring thorough early summer, and several pairs nested on the San Francisco-Oakland Bay Bridge (U.S. Army, 1994). California condors and bald eagles are also found in the coastal zone around San Francisco Bay (FWS, 1981b). The winter-run chinook salmon passes through the Sacramento-San Joaquin Delta, San Pablo Bay, and San Francisco Bay during their upstream and downstream migrations. The adults are present in the Bay area from November to May, and the smelts migrate through the Bay from November through May. The winter-run chinook is fished commercially in North America from Kotzebue Sound, Alaska, to Santa Barbara, California (U.S. Army, 1994).

Open Ocean

Several threatened or endangered species occur either occasionally or periodically in the ocean offshore of the San Francisco area. These include the humpback whale, the blue whale, the sperm whale, and the Stellar sea lion (U.S. Army, 1994). The humpback whale, which has a worldwide range, is typically found in the San Francisco area from March through January. Summer feeding occurs from the Aleutian Islands to the Farallon Islands. The greatest number of blue whales within the Farallon Basin occurs in summer and early fall. The sperm whale regularly occurs in the Gulf of the Farallones in deep oceanic waters, and is rarely reported over the shelf. The Stellar sea lion ranges from California to the Bering Sea. Stellar sea lions have rookeries on Southeast Farallon Islands (as well as other California and Pacific coast sites). The sea lion breeds in the late spring and summer.

Climatic Conditions

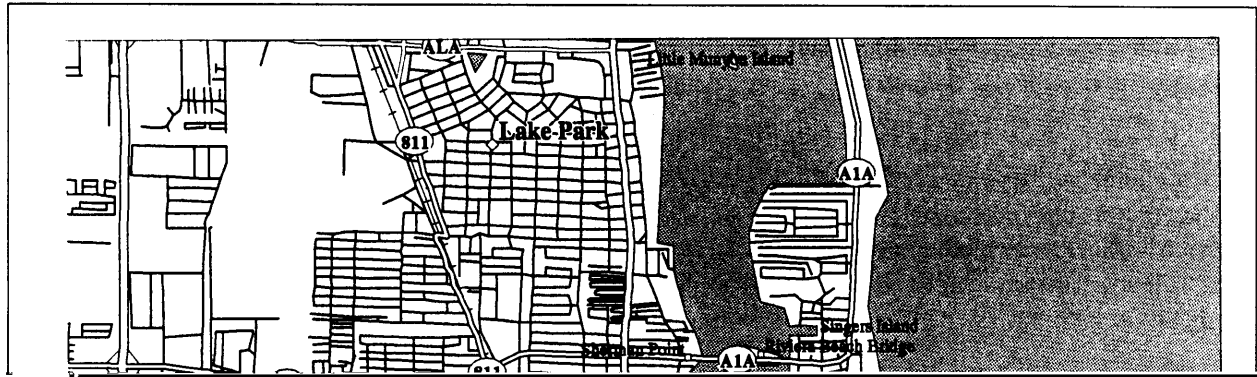
The Oakland, CA, area is classified as a marine climate, which is characterized by mild and moderately wet winters, with cool, dry summers. The winter rains, which occur between November and March, account for over 80 percent of the total annual precipitation. Additionally, severe winter storms, with gale-force winds and heavy rains do occur occasionally. The diurnal temperature range is moderated substantially by marine environment. The summer weather is dominated by a cool sea breeze circulation and a sea fog that arrives in the late evening over the area. The fog generally burns-off in the early morning hours, resulting in relatively sunny summer days (NOAA, 1993d).

D.2.2.16 Palm Beach, FL

The Port of Palm Beach is located 2.0 km (1.1 mi) west of the entrance to Lake North Worth Inlet, which consists of a dredged cut, protected by two jetties, through the barrier beach which forms the resort city of Palm Beach. The port borders the communities of Riviera Beach on the north and West Palm Beach on the south, the latter being connected to Palm Beach by highway bridges spanning Lake Worth. The Port of Palm Beach is 110 km (68 mi) north of Miami and 417 km (259 mi) south of Jacksonville. A Federal project provides for a 10.7 m (35 ft) deep entrance channel with a 10.1 m (33 ft) inner channel to a turning basin of the same depth. The 121.9 m (400 ft) wide entrance channel narrows to 91 m (300 ft) and leads into a 442 m by 399 m (1,450 ft by 1,310 ft) turning basin. Port Authority-owned Peanut Island is located between the inlet entrance and Port of Palm Beach terminals. According to the port's 1993 Annual Report, the controlling depth of the entrance and turning basin was 10.1 m (33 ft) to not less than 7.6 m mean low water (25 ft) at the northern terminal extension (POPB, 1994). A map of the port is shown in Figure D-47.

The Port of Palm Beach is a landlord port with 77 ha (190 acres) of land. The Terminal has two slips and four marginal wharves totalling 1,536 m (5,039 ft) of berthing, including six roll-on/roll-off ramps. Pilots

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connecting with the Florida East Coast Railroad. The Port of Palm Beach is about 2.4 km (1.5 mi) from I-95 and 8.1 km (5 mi) from the entrance to the Florida Turnpike. The route is through light commercial and residential areas (AAPA, 1994).

Other Pertinent Port Information: Palm Beach has an around-the-clock watchman service, is fenced and lighted and has only one controlled entrance/exit. The port handles explosives and other hazardous goods and according to a port official, the port does not have a prohibition against handling spent nuclear fuel (Mets, 1994). As with other small, multi-use ports, there is some apparent conflict between the handling of petroleum products, cruise ship passengers, and spent nuclear fuel all within the confines of a relatively small, environmentally sensitive harbor complex.

The likelihood of severe natural phenomena such as high winds and earthquakes is reflected in the structural requirements for buildings in each area of the United States. These are shown in the Uniform Building Code (UBC, 1991). For the Port of Palm Beach, the Uniform Building Code requires buildings to withstand wind speeds up to 160 km/hr (100 mph). The port is located in a very low seismic zone with an acceleration of less than 0.075 g.

Negotiations for the sale of the port's Peanut Island, mentioned above, to the Florida Inland Navigation District are currently underway. Use of the island would be permanently limited to a partial dredge spoil area, as well as habitat preservation, and a passive recreation area (POPB, 1994; Mets, 1994).

The 1990 population of the combined port area (Riviera, Palm, and West Palm Beach) was approximately 115,000, and the average are density was about 650 persons/km² (1,600 persons/mi²). The affected populations within 0.8 km (0.5 mi) of the interstate routes to the five potential DOE management sites are approximately (based on data for nearby Port Everglades): Savannah River Site, 240,000; Oak Ridge Reservation, 350,000; Idaho National Engineering Laboratory, 780,000; Hanford Site, 790,000; and Nevada Test Site, 800,000. Populations along rail routes to these sites are slightly larger. These populations are shown in Tables D-7 through D-16 in Section D.1. The distances to the five potential sites on interstate routes for nearby Port Everglades are approximately: Savannah River Site, 1,125 km (700 mi); Oak Ridge Reservation, 1,366 km (850 mi); Idaho National Engineering Laboratory, 4,501 km (2,800 mi); Hanford Site, 5,145 km (3,200 mi); and Nevada Test Site, 4,662 km (2,900 mi). Distances along rail routes are slightly longer.

Climatic and environmental conditions are similar to those reported for Port Everglades in Section D.2.2.18.

D.2.2.17 Philadelphia, PA

Philadelphia, one of the chief ports of the United States, is located at the junction of the Delaware and Schuylkill Rivers, approximately 130 km (81 mi) above the entrance to the Delaware Capes. Access to the port is via the Delaware River through the Delaware Bay. Situated directly across the Delaware River from Philadelphia is Camden, NJ, an important shipping center. The shipping activities of the two cities are closely allied; large quantities of general cargo are handled at the Philadelphia port in both domestic and foreign trade. Access to the port is gained via the Delaware Bay and Delaware River (DOC, 1993c). A map of the port (including Camden, NJ immediately opposite) is shown in Figure D-48.

The Delaware Bay has natural depths of 15.4 m (50 ft) or more for a distance of 8 km (5 mi) from the entrance. A Federal project provides depths of 12.2 m (40 ft) from the sea through the Delaware Bay and River to Philadelphia. There are restrictions on the passage through the Delaware Bay and up the Delaware River, such as a traffic separation scheme established off the entrance to the Delaware Bay.

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A P P E N D I X D

Ships going to Philadelphia must also pass under the Delaware Memorial Bridge. Roughly 90 percent of the 58,831,000 metric tons (64,849,000 tons) of cargo handled in 1991 were bulk cargo, and a large share of that is known to be crude oil and refinery products (DOC, 1993c; AAPA, 1993).

With the exception of some privately owned terminals, general cargo facilities (including container terminals on the west side of the Delaware River) are owned by the City of Philadelphia. Across the river on the New Jersey side, cargo terminals belong to the South Jersey Port Corporation, a state agency that operates two terminals and leases the remaining ones to private companies. The Philadelphia Regional Port Authority, apparent successor to the Philadelphia Port Corporation, is responsible for City-owned

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Other Pertinent Information: The container terminals are fenced with controlled access and 24-hour security. It is not known what arrangements exist for temporary storage of hazardous materials, but it is likely such storage is available in a large port facility (Castagnola, 1993). Spokespersons for the South Jersey Port Corporation (Castagnola, 1993; formerly with the Philadelphia Regional Port Authority) and

The Port of Philadelphia is located within Zone 3 (tidal river) of the Delaware River. Protected water used for Zone 3, which encompasses River Mile (RM) 95-108.4, are water supply (agricultural, industry, and public), wildlife, resident fish maintenance, anadromous fish passage, secondary contact, and navigation (DRBC, 1994). However, several uses within Zone 3 are currently impacted, including: 1) fish and other aquatic life due to low dissolved oxygen levels from point source discharges; and 2) fish and shellfish consumption due to chlordane and polychlorinated biphenyl contamination from point and nonpoint source discharges.

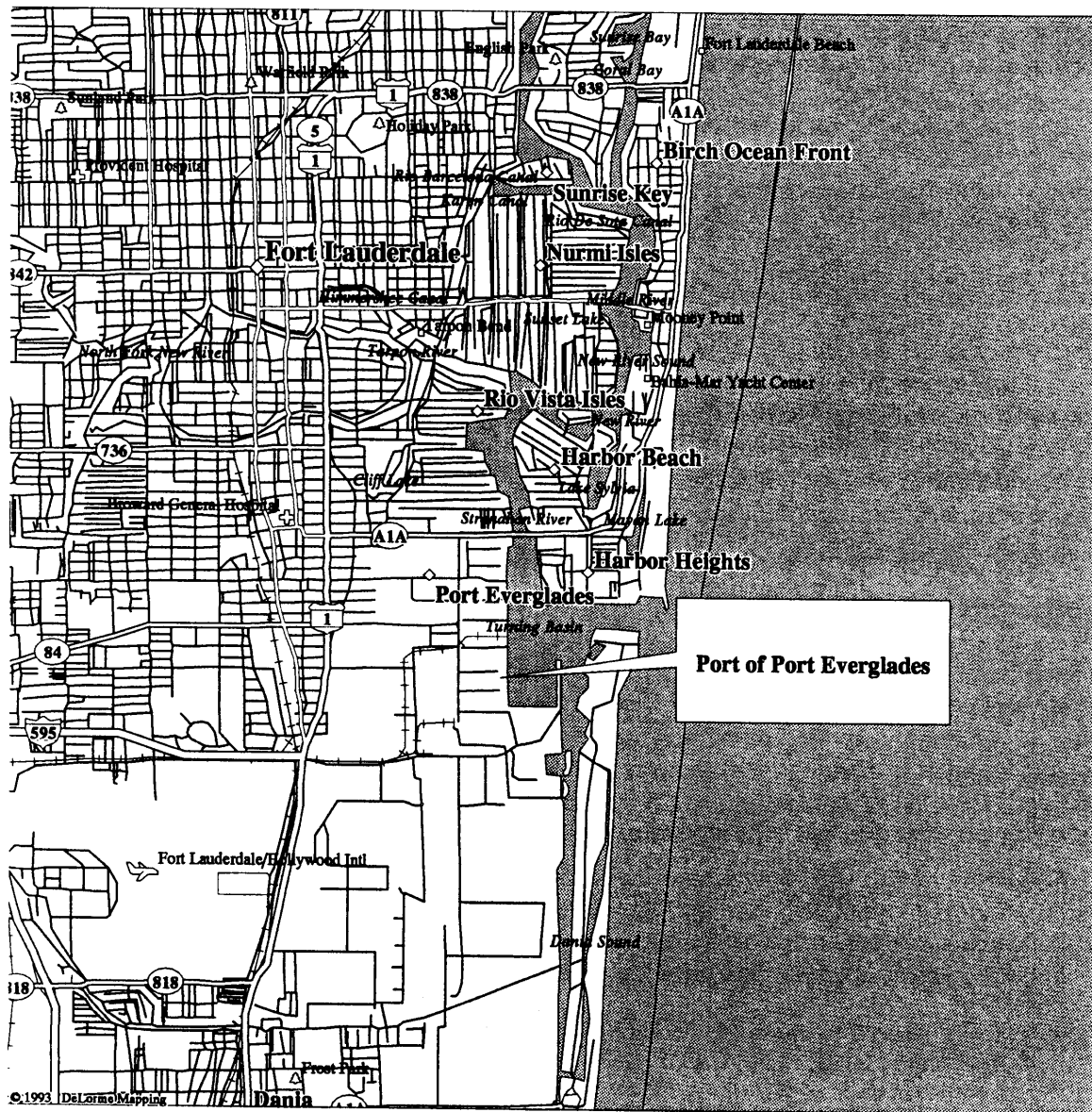
Climatic Conditions

The climate of Philadelphia is moderated by the Appalachian Mountains to the west and the Atlantic Ocean to the east. These geographic features cause periods of extreme temperatures to be short-lived in this region (generally, four days). On occasion during the summer months, the area is dominated by maritime tropical air masses, which contribute to elevated local temperature and humidity levels. The average annual precipitation (41.42 in) is relatively evenly distributed throughout the year, with maximum amounts occurring during the late summer months. The summer precipitation regime is dominated by localized thunderstorms and is subject to the influence of the urban heat island effect and local topography, which create varying rainfall amounts across the city for an individual event. Singular snowfall events that generate accumulated totals of greater than 10-in have a 5-year recurrence interval on average. The prevailing wind direction has a bimodal distribution, being southwesterly during summer and northwesterly in the winter months. The annualized average prevailing wind direction is from the west-southwest. Due to Philadelphia's inland location, destructive winds are comparatively rare from tropical cyclones and tornadoes. High winds are generally associated with frontal passages/low pressure systems in winter and thunderstorms in summer months. However, flooding on the Schuylkill River normally occurs twice annually usually associated with strong thunderstorms, with the duration of these events generally lasting less than 12 hrs. The Delaware River is rarely observed at or above flood stage (NOAA, 1992h).

D.2.2.18 Port Everglades, FL

Port Everglades is a major deepwater port located on Florida's southeast coast. It is located immediately off the Atlantic Ocean along the Inland Waterway, within the three cities of Hollywood, Fort Lauderdale, and Dania (DOC, 1993d; D&B, 1993; Southern Shipper, 1993). The major port facilities are immediately inside the harbor entrance, approximately 1.6 km (1 mi) from the south jetty. The approach to Port Everglades is open, and a relatively short 140 m (450 ft)-wide channel leads directly from the Atlantic Ocean to the port facilities. A Federal project provides for depths of 12.8 m (42 ft) to the main port facilities (DOC, 1993d; D&B, 1993; Jane's, 1992; Southern Shipper, 1993; AAPA, 1994; PEA, 1993).

Port Everglades consists of 850 ha (2,100 acres) of land, of which 360 ha (890 acres) are owned by the Port Everglades Authority Commission (Port Everglades Authority). Considerable foreign commerce passes through Port Everglades, in addition to substantial passenger traffic. Many of the world's large passenger vessels call at Port Everglades (it claims to be the world's second-busiest cruise port) (Southern Shipper, 1993). It is a multi-terminal port with more than 2,800 ship calls annually. The port handles over 1.2 million tons of cargo annually.



"Map(s) from MapExpert, DeLorme Mapping, Freeport, ME."

Figure D-49 Map of Port Everglades, FL

A P P E N D I X D

The Port Everglades Authority is empowered by the State Legislature to act as the governing entity for the operations, maintenance, and management of port and harbor facilities located within the port's jurisdictional area. The Authority is the governing body responsible for strategic planning and policy setting. In November 1994, governing responsibility for the seaport was transferred to the Broward County Government (PEA, 1993).

Principal container handling facilities at the port include Midport and Southport (there is also a Northport terminal as well).

117.8 ha (44 acres) of

There are no known restrictions to the handling of spent nuclear fuel. However, Item 240 of the Port Everglades Authority Tariff states that explosives, hazardous, or highly flammable commodities or materials may only be handled through special arrangement with the Port Authority. Port Officials indicate that their safety policies, which ban oxidizers such as ammonium nitrate and Class A explosives, would also preclude shipments of spent nuclear fuel. As far as is known, spent nuclear fuel shipments have not been handled by the port (Flint et al., 1993).

Port Everglades is the second-largest petroleum distribution facility in the United States (Southern Shipper, 1993). Major oil companies have more than 86 million barrels of tank space for refined petroleum products inshore of the Midport and Northport terminals. With the possible exception of terminal facilities at Southport, which are remote from the tank farms and other conflicting port users, the potential for conflict between cruise ship operations, tanker traffic, and containerized spent nuclear fuel

shipments appears to be great.

Southport Terminal is the preferred terminal, as it is relatively remote from the City of Fort Lauderdale, has direct connection to the Interstate Highway system, and is located in a nonresidential port industrial district. The physical layout and constraints of port waterways, however, combined with its intense use by potentially conflicting types of transport (i.e., cruise ships, tankers and tank barges, container and breakbulk vessels, and recreational traffic, plus a State seashore park on its eastern boundary) detracts from its otherwise superb facilities.

The port is subject to severe hurricanes and tropical storms. The likelihood of severe natural phenomena such as high winds and earthquakes is reflected in the structural requirements for buildings in each area of the United States. These are shown in the Uniform Building Code (UBC, 1991). For Port of Everglades, the Uniform Building Code requires buildings to withstand wind speeds up to 150 km/hr (95 mph). Port Everglades is located in a very low seismic zone with an acceleration of 0.075 g.

The 1990 population within 16 km (10 mi) of the port terminals was 714,176. The affected populations within 0.8 km (0.5 m) of the interstate routes to the 5 potential DOE management sites are: Savannah River Site, 244,000; Oak Ridge Reservation, 352,000; Idaho National Engineering Laboratory, 754,000; Hanford Site, 803,000; and Nevada Test Site, 817,000. Populations along rail routes to these sites are slightly larger. These populations are shown in Figures D-8 through D-17 in Section D.1. The distances to the five potential sites on interstate routes are: Savannah River Site, 1,170 km (726 mi); Oak Ridge Reservation, 1,420 km (884 mi); Idaho National Engineering Laboratory, 4,540 km (2,820 mi); Hanford Site, 5,210 km (3,236 mi); and Nevada Test Site, 4,700 km (2,923 mi). Distances along rail routes are slightly longer.

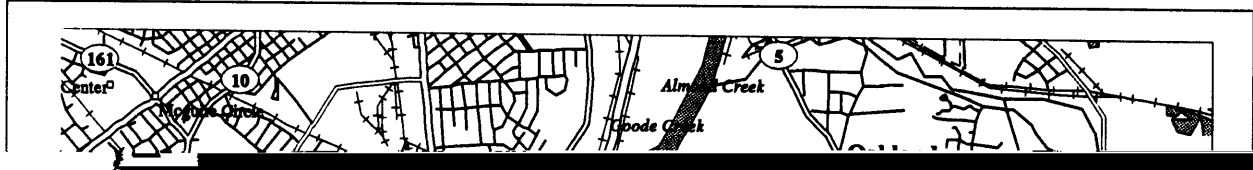
Environmental Conditions

The State of Florida has classified the waters surrounding Port Everglades as Class III. This classification indicates that the waters are suitable for recreation and propagation of fish and shellfish.

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The waters surrounding Port Everglades are characterized as high salinity estuarine habitats (generally

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Richmond Terminal has two marginal berths with a total length of 381 m (1,250 ft) and 7.6 m (25 ft) of water alongside at mean low water. CSX Railroad tracks with multiple sidings serve the port's two warehouses and container storage yards. The Terminal is a container, general cargo, and breakbulk handling facility with roll-on/roll-off vessel and container and trailer on flatcar capabilities. The port has two 209 metric ton (230 ton) and one 319 metric ton (350 ton) capacity crawler cranes outfitted with 22.9 m (75 ft) booms. A new 273 metric ton (300 ton) crane was purchased in April 1994 and set a new accident-free container handling record of 20.43 20-ft equivalent units/hr (PORT, 1994).

The port is about 1.6 km (1 mi) from highway I-95 with travel through an industrial area. It is also served by a trunk railway.

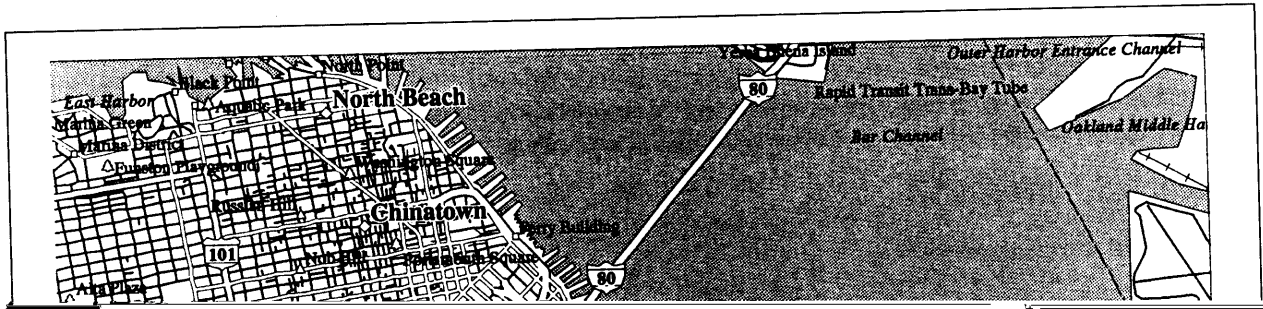
Other Pertinent Port Information: The Port of Richmond has only one entrance which is controlled by a Pinkerton Guard on a 24-hour basis.

... .. the mid-1990s a \$9.10 million expansion program involving a 96 m

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flooding during the summer and early fall. Damaging storms occur mainly from snow and freezing rain in

APPENDIX D



Truck access to the container terminals is via Cargo Way and Third Street. Cargo Way connects South Terminal Piers 94 - 96 with 3rd Street. Entrance to the North Container Terminal (Pier 80) is at the intersection of 3rd Street and Army Street, which connects with I-280 and U.S. Highway 101 about 0.8 km (0.5 mi) from the entrance and about 1.6 km (1 mi) from the entrance to the South Container Terminal. These highways link up with the San Francisco/Oakland Bay Bridge (I-80) — the assumed route to Idaho National Engineering Laboratory and/or points east— which is roughly 1.6 to 2.4 km (1 to 1.5 mi) away. The Southern Pacific Railway serves both the North and South Container Terminals, and the Union Pacific also has tracks to the North Terminal's Pier 80. Trackage at South Terminal extends shipside parallel to the berth. Adjacent to the South Container Terminal is a 14.6 ha (36 acre) intermodal container transfer facility (Jane's, 1993; AAPA, 1993).

San Francisco has been served by a number of major container carriers. Lines calling at South Terminal include Grancolumbiana and Evergreen. Liner companies using North Terminal include Blue Star Line, Central American Container Line, CSAV (Chilean Line), ELMA, Nedlloyd, NSCP, South Seas Shipping, and Splosna Plovba (Jane's, 1992; AAPA, 1993). However, in 1994, four of its five major container lines moved to Oakland (Adams, 1994; Mitchell, 1994).

Other Pertinent Information: Terminal security is the responsibility of the respective terminal operating companies. Facilities are fenced with controlled access and are patrolled by watchmen supplied by the International Longshoremen Workers Union. There are also City police officers permanently assigned for general port security (Mitchell, 1994). There are places within the container terminals for temporary segregation and storage of hazardous materials (Mitchell, 1993).

There are no regulations prohibiting the handling of containerized spent nuclear fuel. The port handles hazardous cargoes but, as far as known, has not handled spent nuclear fuel. The port allows Class A and B explosives in small amounts only (Mitchell, 1994).

All of San Francisco's marine terminals are located within the densely populated downtown area of the city and the large tourist population. Although there appears to be conflicting use of the Port of San Francisco's marine facilities (primarily attributable to its tourism business, much of which is centered to the north and west of the port's two container terminals) it is not deemed a major consideration. Terminal operators are responsible for accidents within their respective facilities. The Port Authority will

acceleration of 0.40 g, the highest seismic ranking in the United States. High winds have not been a problem for the Bay, with a Uniform Building Code minimum basic wind speeds up to 140 km/hr [70 miles per hour (mph)].

The climatic and environmental conditions of the Port of San Francisco are the same as those reported for the Port of Oakland in Section D.2.2.15.

The 1990 population within 16 km (10 mi) of the port terminals was 1,265,529. The affected populations within 0.8 km (0.5 mi) of the interstate routes to the five potential DOE management sites are: Savannah River Site, 1,060,000; Oak Ridge Reservation, 766,000; Idaho National Engineering Laboratory, 348,000; Hanford Site, 339,000; and Nevada Test Site, 461,000. Populations along rail routes to these sites are slightly larger. These populations are shown in Figures D-8 through D-17 in Section D.1. The distances to the five potential sites on interstate routes are: Savannah River Site, 4,570 km (2,803 mi); Oak Ridge Reservation, 4,130 m (2,567 mi); Idaho National Engineering Laboratory, 1,560 m (970 mi); Hanford Site, 1,420 km (882 mi); and Nevada Test Site, 1,160 km (722 mi). Distances along rail routes are slightly longer.

D.2.2.21 Seattle, WA

The Port of Seattle, WA, is located 230 km (143 mi) from the confluence of the Strait of Juan de Fuca and the Pacific Ocean. Seattle is located on Elliott Bay on the eastern shore of the Puget Sound, about 93 km (50 mi) south of the Strait of Juan de Fuca and about 5 km (3 mi) from the Sound. It is the largest and most important city in the Northwest, and one of the major ports on the Pacific Coast. Access from the Pacific Ocean is gained through the Strait of Juan de Fuca and Puget Sound. The transit from the Pacific Ocean to Seattle is open and considered relatively easy, with very deep waters during the entire approach to Seattle (DOC, 1992b). A map of the port is shown in Figure D-52.

The Port of Seattle is a large, diversified, multi-terminal port. Overall container tonnage for 1992 amounted to 7,510,000 metric tons (8,278,300 tons) and 1,155,000 20-ft equivalent units. It is managed by the Managing Director of the Marine Division and staff. Its facilities are municipally owned and leased to tenants (i.e., the Port Authority operates as a Landlord owner) (POS, 1994).

The port has five container terminals, of which two, Terminals 5 and 18, are considered public facilities:

Terminal 5: T5 is located on the West Waterway and is leased to and operated by American President Lines. Terminal 5 has a total area of 36 ha (89 acres), of which 24 ha (59 acres) can be used for container handling and storage. It has three container berths (Berths 4, 5, and 6), is equipped with six 50.8 metric ton (56 ton) Post-Panamax container cranes, and has two container freight stations. Terminal 5 has 760 m (2,500 ft) of marginal wharf, with 12.19 m (40 ft) of water alongside at mean low water. The terminal has good access to Interstate 5; about 3.8 km (2.4 mi) from the ramp to I-5 following a route entirely within the port's industrial district via North Marginal Way and West Seattle Freeway to South Spokane Street. I-5 is the principal north/south roadway linking Seattle with I-84 at Portland, OR (the assumed preferred, year-around route to Idaho National Engineering Laboratory) and/or I-90/82, which also links up with I-84 near Pendleton, OR. Terminal 5 is served by the Burlington Northern Railroad, whose tracks are located at the rear of the Terminal. The port is considering a proposal to provide Union Pacific service (Benham et al., 1994). Terminal 5 is served by major container lines including APL, OOCL, Star Shipping, and Westwood Shipping (Jane's, 1992; AAPA, 1993; D&B, 1993).

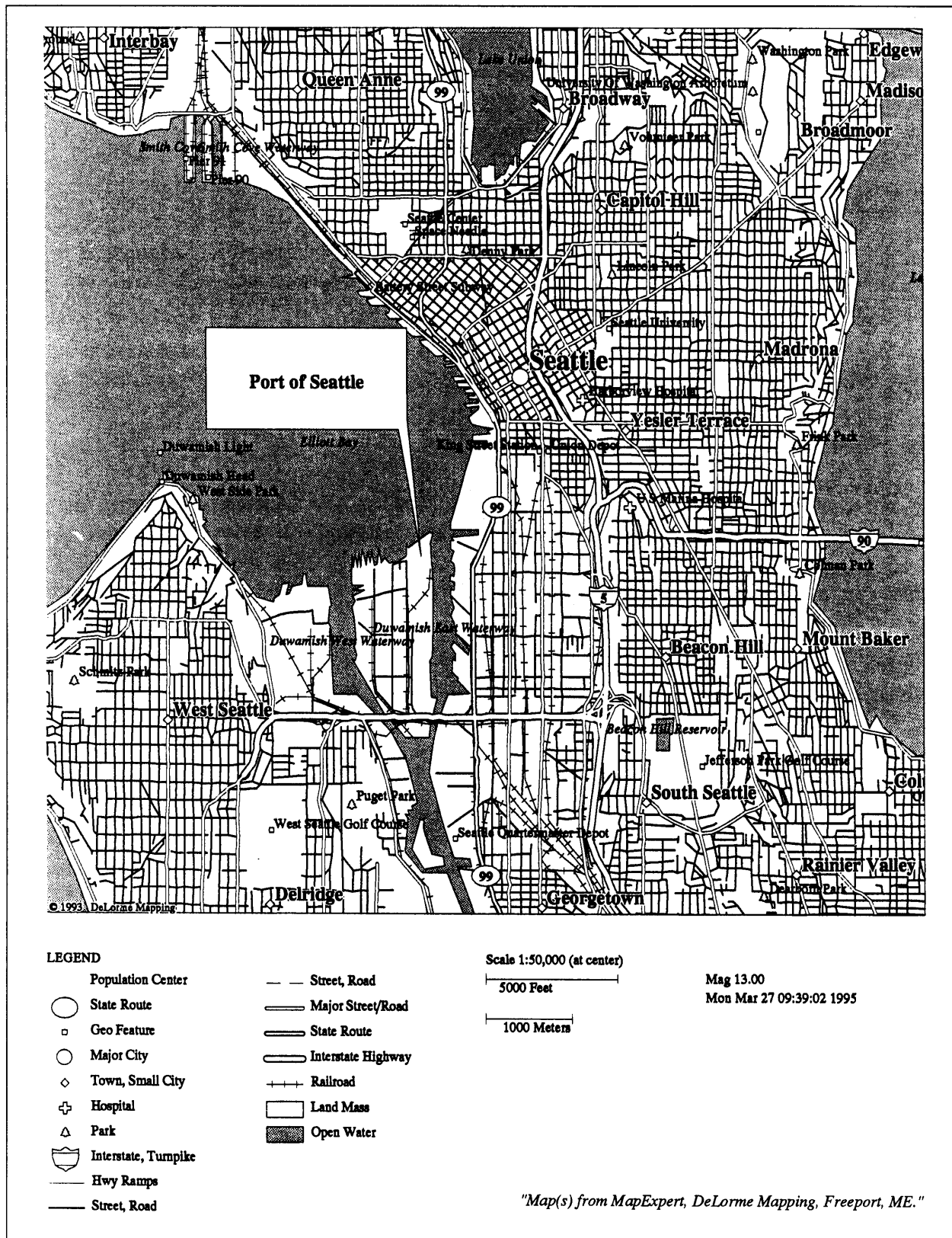


Figure D-52 Map of the Port of Seattle, WA

Terminal 18: T18 is located on the East Waterway (Berths 1 - 4, and 5 - 8), is operated by Stevedoring Services of America, and has a total area of 47 ha (116 acres) devoted to container handling and storage. It is also equipped with six, 40.6 metric ton (45 ton) container cranes and container freight stations. Terminal 18 has 1,844 m (6,049 ft) of marginal wharf, with 15.24 m (50 ft) of water alongside at mean low water. The terminal also has good access to Interstate 5; about 2.9 km (1.8 mi) from the ramp to I-5 following a route that is also entirely within the port's industrial district via South Spokane Street. Terminal 18 is also served by the Burlington Northern as well as the Union Pacific railroads via tracks along the wharf apron (i.e., ship-side).

Terminal 18 is served by several major container lines, including Barber Blue Sea, Grancolombiana Line, COSCO, d'Amico Line, Japan Line, Hyundai, Scindia Line, Chilean Line, ACL/CGM and P&O

Other Pertinent Information: There are potentially conflicting activities near the Terminal; petroleum products are pumped ashore at Terminal 5 (Berths 4 and 5), and across the East Waterway at Terminal 18 (Berths 2 and 3). The terminals are fenced with controlled access and guarded by watchmen on a 24-hour basis. There are areas within the container terminals for segregating hazardous materials cargoes.

The port's Emergency Response Plan relies on the City of Seattle Fire Department for hazardous materials response, with a technical support team including spent nuclear fuel handling experts from the DOE Hanford Site hazardous materials training for port workers is the responsibility of the individual terminal operators (Benham and Schuler, 1993; Benham et al., 1994). As noted in the accident information for Tacoma, the overall ship accident rates in the Puget Sound for the 1991-1993 reporting period are relatively low (USCG, 1994b).

from Canada to Northern California, are volcanic in origin and are potentially active (Foster, 1971; Hamilton, 1976; IPA, 1993). The likelihood of severe natural phenomena, such as high winds and earthquakes, is reflected in the structural requirements for buildings in each area of the United States. These are shown in the Uniform Building Code (UBC, 1991). For the Port of Seattle, the Uniform Building Code requires buildings to withstand wind speeds up to 120 km/hr (80 mph). The port is located

in a high seismic zone with an acceleration of 0.30 g.

The 1990 population within 16 km (10 mi) of the port terminals was 753,296. The affected populations within 0.8 km (0.5 mi) of the interstate routes to the five potential DOE management sites are: Savannah River Site, 565,000; Oak Ridge Reservation, 395,000; Idaho National Engineering Laboratory, 122,000; Hanford Site, 62,900; and Nevada Test Site, 344,000. Populations along rail routes to these sites are slightly larger. These populations are shown in Figures D-8 through D-17 in Section D.1. The distances to the five potential sites on interstate routes are: Savannah River Site, 4,670 km (2,900 mi); Oak Ridge Reservation, 4,240 km (2,636 mi); Idaho National Engineering Laboratory, 1,280 km (793 mi); Hanford Site, 360 km (226 mi); and Nevada Test Site, 2,130 km (1,322 mi). Distances along rail routes are slightly longer.

Environmental Conditions

A variety of aquatic species can be found in Puget Sound. Several animal species with special status may also be found in this area. A variety of marine mammals can be found in the central Puget Sound

The city of Seattle is situated on a low ridge lying between Puget Sound on the west and the Green River valley on the east. The Olympic Mountains, which rise steeply from the Puget Sound are located approximately 80 km (50 mi) to the northwest. The mild climate of the Pacific Coast is modified by the Cascade Mountains and to a lesser extent by the Olympic Mountains. The climate is characterized by mild temperatures, a well-defined rainy season and prolonged cloud cover, especially during the winter months. The Cascades act as a very effective barrier in both winter and summer, shielding the region from both extreme cold and heat, respectively. The rainy season extends from October through March, with December accounting for the most rainfall. Approximately 75 percent of the annual total precipitation occurs during the winter rainy season. The dry season is centered around July and August. The majority of Seattle's precipitation is associated with normal, mid-latitude disturbances, which are most vigorous during the winter months. During summer, the dominant storm track (e.g., the polar jet) shifts northward into southern Canada, reducing the precipitation in the area. Summer thunderstorms do occur but do not contribute measurably to the annual rainfall budget. Prevailing winds are from the southwest, but occasional severe winter storms will produce strong northerly winds. Summer winds are generally rather light, with the occasional evidence of land-sea breeze effects creating northerly flows. Fog and low-level stratocumulus clouds form over the southern Puget Sound area in the late summer, fall, and early winter months, and often dominate the weather conditions of the early morning hours, reducing surface visibilities. Based on the 1951-1980 climatology, the first occurrence of freezing temperatures should occur around November 11, and the last incidence in spring around March 24 (NOAA, 1992g).

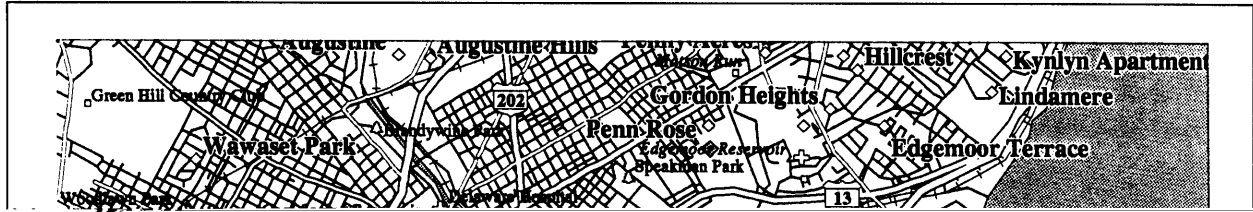
D.2.2.22 Wilmington, DE

The city of Wilmington, DE, sited on the Christina River, has large manufacturing interests. Both sides of the river at the city are lined with wharves that primarily support barge traffic. Deepwater facilities are located at the Port of Wilmington on the south side of the Christina River. The port is located about 3 km (2 mi) north of the Delaware Memorial Bridge on the left ascending bank of the Delaware River, approximately 100 km (62 mi) above the entrance to the Delaware Capes. The port is south of the city of Wilmington and is situated in an area of heavy industrial usage, which appears to be remote from residential, light business, and manufacturing areas (DOC, 1993c). A map of the city is shown in Figure D-53.

Access to the Port of Wilmington is gained via the Delaware Bay and Delaware River. The bay has natural depths of 15.4 m (50 ft) or more for a distance of 8 km (5 mi) from the entrance. A Federal project provides depths of 12.2 m (40 ft) past the entrance to the Christina River where the project depth is 10.6 m (35 ft). A traffic separation scheme has been established off the entrance of the Delaware Bay because of restrictions on passage through the bay and on up the Delaware River. Ships travelling to Wilmington must pass under the Delaware Memorial Bridge (DOC, 1993c).

The port is owned by the City of Wilmington. It is an "operating" port with stevedoring handled by two outside stevedoring companies. Principal cargoes are imported automobiles, dry bulk, roll-on/roll-off and refrigerated containers (primarily bananas and other tropical fruit) (POW, 1994). In 1993, the port handled about 936,000 metric tons (1,026,397 tons) of containerized cargo (about 100,000 20-ft equivalent units; AAPA, 1994). The port has 10,218 m² (110,000 ft²) of chill/heat space and 36,806 m³ (1,300,000 ft³) of chill/freezer warehouse space. The terminal has two multi-purpose container cranes and one bulk cargo gantry crane. The marginal wharf area is 1,158 m (3,800 ft) long and there is a 155 m (510 ft) long floating roll-on/roll-off berth. Depth alongside the terminal at mean low water ranges from 11.58 m (38 ft) to 10.67 m (35 ft) due to silting. The port is equipped with one 40.6 metric ton (45 ton) multi-purpose container crane, one 29.1 metric ton (32 ton) multi-purpose container crane, and one 11 m³ (14 yd³) Clyde gantry crane (AAPA, 1993; Jane's, 1992; POW, 1994). Approximately half of the cargo going in and out

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of the port is food. Improved tropical fruit comprised 35 percent of the traffic in the port, while manufactured food products and finished perishables make up another 15 percent of the cargo traffic. Forest products handle 15 percent of the cargo traffic and imported steel makes up 7 percent. Several bulk commodities that are nonhazardous are the remaining 28 percent of the cargo handled by the port (Brooks, 1994).

The Port of Wilmington has direct access to I-495, a connector to I-95, which appears to be less than 1.6 km (1 mi) from the port.

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[REDACTED]

[REDACTED]

[REDACTED]

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D.3 Main Routes

The routes selected for potential marine transport are discussed in Appendix C. These routes cover the transport of the spent nuclear fuel from the country of origin to the first port of call in the United States. In the port incident-free and accident analysis it has been assumed that the vessel carrying the spent nuclear fuel would not unload the material at its first port of call. Intermediate port calls have been assumed in the analysis. In the marine impact accident and incident-free analysis, the intermediate port calls result in additional travel time which has been incorporated into both analyses. In the port analysis, this results in additional workers who could be affected by incident-free impacts and additional locations where accidents could occur. Due to the large variability associated with the movement of the vessel between U.S. ports, no specific route has been identified for use in the analysis. With the approach used in this analysis, the specific routes used between the U.S. ports would not affect the results of the risk assessment.

D.4 Accident-Free Impacts: Methods and Results

D.4.1 Introduction

This section of the appendix provides an overview of the approach used to assess the risks associated with port activities involved in transferring the spent nuclear fuel from the vessel to a vehicle for transport to the management site. Included here is a discussion of the incident-free risk assessment methodology and the results of the analyses, including an assessment of the cumulative risk associated with the marine transportation of the foreign research reactor spent nuclear fuel through U.S. ports.

The risk assessment results are presented in terms of a per shipment risk, annual risks from incident-free transport, as well as for the total risks associated with the program.

D.4.2 Scope

All foreign research reactor spent nuclear fuel shipments that would require ocean transport are expected to occur via one of four types of vessels: container ships, roll-on/roll-off vessels, general cargo (breakbulk) vessels, or purpose built vessels. In the incident-free analysis, it has been assumed that all shipments are made on either a breakbulk or a container vessel, an assumption intended to provide bounding assessments of the risks associated with port activities required for the transfer of spent nuclear fuel.

D.4.2.1 Nonradiological Risk of Marine Transportation Related Activities

This portion of the risk assessment is limited to estimating the human health risks incurred during spent nuclear fuel unloading and handling during port operations at U.S. ports and during the vessel's approach to the port and movement within the port. The nonradiological risks from these activities were assessed as resulting in a negligible impact on the health of the public and workers. Approximately 56,000 port calls involving vessels engaged in foreign trade are made at U.S. ports every year (DOC, 1994). As discussed in Appendix C, each of these vessels has the capacity to carry hundreds of pieces of cargo of the size of a container carrying a spent nuclear fuel transportation cask (typically, container vessels carry between 800-1,000 containers, while some carry many more). This translates to millions of pieces of cargo every year. To fulfill the needs of the basic implementation of Management Alternative 1 of the proposed action, less than 60 transportation casks would need to be shipped per year. This is less than 0.001 percent

of the total number of pieces of cargo (originating in foreign countries) to be handled at U.S. ports each year. The limited number of shipments per year should not result in a significant change to the risks to the public including the port workers.

D.4.2.2 Radiological Risks of Marine Transportation

The risks that result from the radioactive nature of the shipments are addressed for both incident-free transportation and accident conditions. The radiological risks associated with the incident-free shipping conditions result from the potential exposure of members of the crew and dock workers to external radiation in the vicinity of the packaged fuel. No other exposure is considered, due to the relative isolation of the material from the general public during all phases of the port activities associated with the transfer of the spent nuclear fuel from the ocean going vessel to the overland transportation mode.

All radiologically-related impacts are calculated in terms of committed dose and associated health effects in the exposed populations. The radiation dose calculated is the total effective dose equivalent, which is the sum of the effective dose equivalent (EDE) from the external radiation exposure and the 50-year committed effective dose equivalent from internal radiation exposure. The EDE is the sum of the tissue and organ weighted dose equivalents for all irradiated tissues and organs. The committed effective dose equivalent considers the initial exposure and the effects of radioactive decay and elimination of the radionuclide through ordinary metabolic processes over the 50-year period. Radiation doses are presented in units of person-rem for collective population and rem for individuals. The impacts are further expressed as health risks, primarily in terms of latent cancer fatalities (LCF). The health risk conversion factors were derived from International Commission of Radiological Protection Publication 60 (ICRP, 1991).

D.4.3 Port Facility Operations

This section describes the principal activities that are performed at a port facility to transfer a radioactive material package ("cask") from an ocean vessel to a surface conveyance, such as a truck trailer or railcar. The purpose of this description is to assist in establishing an estimate of the ionizing radiation dose to personnel that could be associated with the port intermodal transfer. The description of activities, and estimates of durations of specific tasks and personnel requirements is presented later in this section.

The off-load operation would take place at a "facility of particular hazard," as defined in 33 CFR 126.05, that is designated by the Captain of the Port. The Captain of the Port is a U.S. Coast Guard officer that enforces, within his/her respective port, safety, security and marine environmental protection regulations. These include, without limitation, regulations for the protection and security of vessels, harbors, and waterfront facilities; anchorages; security of vessels; waterfront facilities; security zones; safety zones; regulated navigation areas; deepwater ports; water pollution; and ports and waterway safety. The Captain of the Port designates and permits "facilities of particular hazard."

Such a facility is allowed to handle "cargoes of particular hazard" including "highway route controlled quantities of radioactive material," which includes spent nuclear fuel. The Captain of the Port could establish a safety zone or security zone around the vessel, if necessary. These zones would prohibit unauthorized personnel from entering the area. Usually a "facility of particular hazard" will have a secured area onsite for the storage of "cargoes of particular hazard." This facility would be used for the temporary storage of spent nuclear fuel, if necessary. Usually, these cargoes are loaded on a truck or train that departs for its destination soon after being checked by a facility employee and inspected by the proper authorities.

Each "facility of particular hazard" has an operations manual that outlines procedures for handling "cargoes of particular hazard," the personnel used and their qualifications, emergency procedures, and contact numbers. Only the Captain of the Port can approve the required operations manual, and only the Captain of the Port can approve any changes made to the operations manual. The content of the operations manuals can vary by port location and size, and by the type of materials handled. The operations manual of the facility under consideration for off-load operations should be studied prior to receipt of any spent nuclear fuel.

D.4.3.1 Intermodal Transfers

The intermodal transfer of the container (or cask) is largely a mechanical lifting operation with somewhat limited personnel participation. Unloading of vessels is generally performed by members of the International Brotherhood of Longshoremen (East Coast and Gulf Ports), or the International Longshoremen and Warehouseman Union ("Longshoreman") (West Coast ports), sometimes with support from the vessel's crew.

There are various configurations of container (or cask) storage aboard ship that could arise. However, as a preference, containers (or casks) are transported below decks. The following sections describe the principal operations that must occur to achieve both transfer of the container (or cask) from the ship, and to prepare it for departure from the port. It should be noted that as a general rule, departure from the port

The receiver (or the agent for the receiver) generally arranges with the Longshoremen to install the cask container directly onto the container trailer, or railcar, which will be used for overland transport, and which has already been inspected. The container trailer will be pulled by the tractor which is to be used for transport.

If the containerized cask is placed on a dock container trailer, sometimes called a "bombcart," then it must be later moved to the trailer which is to be used for transport. This transfer can be made using a large, industrial fork lift, top lift, or a small mobile crane ("forklift") specifically designed to move containers in the port freight staging areas. A bombcart is a special container trailer, used only within the port facility, that does not have twistlocks at its four corners to secure the container being loaded or unloaded.

Spotting the container on its designated trailer (or railcar) and securing it using the trailer mounted International Standards Organization locks, requires two (2), or four (4) longshoremen (at each end of the trailer) and takes about 30 seconds. Four (4) longshoremen have been used for this task at some ports. Once the container has been loaded onto its trailer, it moves immediately away from the container unloading area to a staging area so that ship unloading can continue. The staging area is established by port authorities, but must be approved by the Captain of the Port.

The staging area is usually close to the container unloading area, on the port property, and may be an area where hazardous materials are routinely handled. It may be an indoor location, such as a warehouse. It is used for the conduct of any inspections or surveys that may be desired, to verify documentation received from the ship's captain, to verify marks and labels on the containers, to verify securement of the load, to assemble required documentation for the overland portion of the transport, and install or verify placards. (It should be noted that foreign origin shipments are prepared in accordance with International Atomic Energy Agency standards, which are generally compatible with NRC and the Department of Transportation regulations. In accordance with International Atomic Energy Agency regulations, containers usually are prepared with an oversized label, which is an International Atomic Energy Agency permitted substitute for placards. Even if placarded, the placards usually do not conform to the "Highway Route Controlled Quantity" placard used for these types of shipments in the United States. The overland portion of the transport leaves from this area. Inspections are described in Section D.4.4.

The National Defense Authorization Act for Fiscal Year 1994 requires that, to the extent practicable, casks containing spent nuclear fuel should be moved expeditiously from the port. However, infrequently, continuation of the transport may not occur immediately. This may be due to unplanned events such as severe weather, equipment breakdown or inspection discrepancy, or to planned actions such as queuing of the receipt of individual containers at the receiving site. If one or more containers must remain at the port, they are normally moved to a bonded warehouse, with the container remaining on its transporter. The warehouse is considered a secure area, and it typically meets the requirements of a "safe haven."

Specific handling for rail shipments depends upon the location of rail track with respect to the container handling crane "foot print." If the rail line is within the foot print, then containers are loaded directly onto the railcars and secured using International Standards Organization locks in the deck of the railcar. Typically, two containers are loaded onto each railcar. If the rail line is not in the foot print, then the container is loaded onto a dock container trailer and moved to the rail line. An industrial forklift is used to transfer the container to the railcar. Railcars may be moved by a switch engine, but more commonly, a railcar tugger is used.

For spent fuel shipments, the railcars carrying loaded containers are separated from each other by buffer cars. These cars are usually empty gondolas or flat cars. A caboose is usually provided for escorts and required security equipment. The buffer cars are selected so that the escorts can have a good view of the container cars. Containers mounted on container trailers are not shipped on the railcar in a "piggyback" configuration because of concerns related to the resulting high center of gravity.

D.4.3.1.2 Container Transfer Using Jib-Type Cranes

The port may not have a container crane and instead rely on a dockside, pedestal mounted, or ship installed, jib crane. Containers are moved using this type of crane by attaching a four-legged sling to the crane hook, and extending one leg of the sling to each of the four corners of the container. The sling must be manually attached to (and later removed from) the International Standards Organization fitting at the top of the corner posts of the container. The attachment and removal is done by two longshoremen, who must climb on top of the container.

The attachment of the sling can take as long as three minutes. The reason for this is that, typically, the longshoremen climb onto the container before the crane operator has positioned the crane and lower the sling for attachment. The longshoremen also provide hand signals to direct the positioning for the crane. Disconnecting the sling from the container is done more quickly, and it is usually not necessary to climb onto the top of the container. Two longshoremen usually lock the container to the container trailer and disconnect the sling, but sometimes four are used.

If the ship is equipped with a jib crane, it may also be used to remove containers. The process is the same as with a dock mounted crane, but the crane is operated by a member of the ships crew. Except for the operation of a ship mounted crane, members of the ships crew do not generally have a role in the unloading of the ship.

D.4.3.1.3 Roll-on/Roll-off Operations

In the roll-on/roll-off configuration the casks (either containerized, freestanding, or palletized) are already on the trailer that is used for overland transport. After unlashings, the trailer is moved to the staging area by a longshoreman using a dock tractor.

Unlashing of the trailer may involve up to four longshoremen, and require up to 5 minutes. Transfer of the trailer to the staging area can take as long as 15 minutes depending on the ship's hold and ramp conditions and the distance to the staging area. After the trailer is spotted in the staging area it is connected to the tractor that is used for over-the-road transport.

Since the trailer has not been available for inspection, if an inspection is required [other than that done by the tractor driver(s)], it is performed at the staging area. If the trailer is foreign owned, temporary apportioned motor vehicle tags are provided by the receiver or receivers' agent.

D.4.3.1.4 General Cargo Operations

Breakbulk operations could involve either a containerized or free standing cask. Typically, a free standing cask is mounted on a pallet to facilitate the handling of the cask using the cranes and winches commonly found on ships and at dock side. Handling of a containerized cask would follow the same operation described in Section D.4.3.1.1.

Breakbulk cargo handling of a free standing cask is more labor intensive, since the cask must be unlashed from the deck and may have to be moved using winches to a hatch opening. A crane is used to lift the cask out of the hold and onto the dock. Up to 4 longshoremen may be used to move the cask in the hold and attach crane rigging to the cask or pallet. Two (2) or more longshoremen may be required to complete the transfer to the dock. At the dock, the pallet is typically placed on a standard flat bed trailer and secured with chains or other binders. Total handling time is less if the cask is transported in the center of the hold, as it likely would be if a chartered vessel were used.

In general, breakbulk cargo requires the longest unloading times, compared to containerized freight and roll-on/roll-off configurations. While a good unloading time for general cargo is about 5 minutes per crane load, radioactive materials transfer can take as long as 20 minutes if the cask is not transported on a pallet and must be rigged separately.

Breakbulk shipment of free standing spent nuclear fuel casks is perceived to result in a somewhat less reliable tiedown of the cask to the deck of the vessel. There is also an increased risk of damage to the cask or its pallet due to the variability in lift fixtures on each pallet. For these reasons breakbulk shipments of spent fuel casks have not been routinely made since the mid 1970's. This mode of shipment is not expected to be routinely used for the transport of spent nuclear fuel, except as it would apply to the use of purpose-built ships.

D.4.3.2 Key Intermodal Tasks and Task Durations

This section summarizes the key intermodal handling tasks, and estimates the personnel requirements and task durations for the transfer of the casks from the vessel to the land conveyance. These summaries are based on the narratives presented previously. Actual handling times and resource requirements can be widely variable, depending in large degree upon the cask configuration, transport vessel, intermodal handling equipment, port practice, and specific procedures which could be implemented for a given shipment or shipping program.

Port inspections are described separately in Section D.4.4.

D.4.3.2.1 Intermodal Handling of Containerized Casks

Ports equipped for intermodal handling of containers have achieved average rates of transfer of general cargo containers between the vessel and dock of 45 per hour, or about one container each 80 seconds. This rate may not be achieved for containers carrying spent nuclear fuel. For conservatism, a transfer time of 2 minutes per container is assumed. Longer transfer times would be expected if the port is not equipped with container cranes. A transfer time of 3 minutes is assumed if jib or boom type cranes are used with slings to lift the containers. Containers are assumed to be installed on the container trailer which would be used in over-the-road transport.

Port practices, such as union rules and safety procedures, would dictate the number of personnel used to unlash, transfer, and lash the container to its transporter. Consequently, the number of personnel required for each task could vary slightly between ports.

Each shipment, consisting of one or more containers, is expected to be observed by one or more persons who represent various interests in the shipment. These observers would have no active role in the transfer of the container, and would be expected to be 9.1 m (30 ft) or more away from the container.

Vessel crew members do not normally participate in container transfer operations, except for a member having responsibility for the cargo. Only this individual is considered to be present during transfer, stationed at the vessel hatch.

Table D-8 summarizes the handling of a container on a container ship. All of the distances are assumed to be from the container surface, or the projected container surface if an open container is used. There are no tasks which require contact with the cask surface.

Table D-8 Container Transfer Summary

<i>Task</i>	<i>Unlash Cargo</i>	<i>Attach to Crane²</i>	<i>Transfer to Dock</i>	<i>Lash to Transporter</i>	<i>Move to Staging</i>
<i>Personnel location</i>					

Table D-9 Roll-on/Roll-off Cask Transfer Summary

<i>Task</i>					
<i>Personnel/Location</i>	<i>Unlash Cargo</i>	<i>Attach to Crane</i>	<i>Transfer to Dock</i>	<i>Lash to Transporter</i>	<i>Move to Staging</i>
0-9 m (0-3 ft)	4 ^a	2 ^a	-	4 ^a	-
duration (min)	4	0.5	-	0.5	-
1.5-3 m (5-10 ft)	-	-	1 ^b	-	-
duration (min)	-	-	0.25	-	-
3-6 m (10-20 ft)	1 ^a	1 ^b	1 ^b	2 ^b	1 ^b
duration (min)	4	0.5	2	0.5	3
6-9 m (20-30 ft)	1 ^c	1 ^c	1 ^c	-	-
duration (min)	4	0.5	0.25	-	-
9 m (30 ft)	-	-	-	4 ^d	4 ^d
duration (min)	-	-	-	0.5	0.25

^a longshoremen

^b truck driver

^c ships crew

^d observer

D.4.3.2.3 Intermodal Handling of Free-Standing (Palletized) Casks

As previously noted, casks are expected to be mounted on a skid, cradle or pallet ("pallet") to facilitate handling, lifting, and stowage. Transfer of these casks is usually somewhat more labor intensive than handling containerized casks, since the pallets are not standardized. The pallets are usually uniquely designed to accommodate a specific cask. Consequently, more effort is usually required to secure the cask in stowage, and to install lift slings for transfer. In addition, some care is needed to ensure that lifting and handling operations do not damage the cask.

Assumptions regarding port practices, observers, and crew members are the same as those made for containerized cask transfer.

It is assumed that the palletized cask would be installed on a flat bed trailer not necessarily having the tiedown fixtures required to secure the pallet. Some additional effort is expected to be required to secure the pallet to a trailer, compared to that required for containerized casks. However, it is assumed that the pallet is placed on the trailer that would be used for over-the-road transport so that no subsequent transfer of the pallet is needed.

Table D-10 summarizes the palletized cask unloading and transfer activities for a breakbulk cargo vessel. Distances are from the edge of the pallet, or its projected edge. There are no tasks which require contact with the cask surface.

D.4.4 Port Inspection Activities

There are several agencies, both Federal and State that could make an inspection of the cargo at any point from when the vessel docked while the cargo is still on board, until the cargo reaches its final resting place in the facility. The U.S. Coast Guard has recently designated personnel to inspect hazardous cargoes, specifically containers laden with hazardous cargo. The U.S. Coast Guard, however, has no current programs in place for the training of inspectors of radioactive materials. This may change in the near future. The U.S. Coast Guard does have an aggressive program for container inspection and compliance. The U.S. Coast Guard would perform an inspection on the vessel, including all documentation (bills of

Table D-10 Palletized Cask Transfer Summary

Task	Unlash Cask	Move to Hot Cell	Attach to Crane	Transfer to Deck	Lash ^b to Transporter	Move to Staging
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The representative of the receiver normally verifies that the marks and labels of the container conform to the documentation supplied by the shipper, that radiation levels are within U.S. regulatory limits, and that they conform to the radiation survey documents supplied with the shipping papers. These verifications are usually made after the container is removed from the ship and is in place on its transporter. Surveys of the container can also be performed aboard ship. This may be done for example, if there was a belief that actual radiation readings could be higher than those reported in the shipment documentation because of some event that occurred in transit, or for information.

Inspections of the transport equipment may be required by the State. These inspections are normally done prior to loading of the container on the bed of the trailer or railcar. This ensures that the container is loaded on an acceptable transporter. There is no radiation exposure which is attributable to this inspection. Verification of container tiedown is performed by the truck driver, or rail crew, as required by current regulations. Typically, tiedowns are also verified by a representative of the consignee. Tasks and personnel requirements are summarized in Table D-11.

Table D-11 Summary of Inspection Tasks and Personnel Requirements Per Container^a

		Federal Agencies ^b			State	Local/Port	Receiver
		USCG	DOT	NRC			
Container	Personnel	1	1	1	1	1	1
	Time (min)	5	2	2	2	5	5
Roll-on/Roll-off	Personnel	1	1 ^c	1	1 ^c	1	1
	Time (min)	2	15	10	15	5	5
Breakbulk	Personnel	1	1 ^c	1	1 ^c	1	1
	Time (min)	2	15	10	15	5	5

^aPersonnel expected to be within 3 m (10 ft) of the container.

^bDiscretionary inspections which may be performed; USCG = U.S. Coast Guard, DOT = Department of Transportation.

^cIncludes trailer inspection.

D.4.5 Port Worker Incident-Free Analysis Methodology

Incident-free impacts of the offloading of foreign research reactor spent nuclear fuel have been estimated for port workers, inspectors, and observers of the activity. It has been assumed that no member of the public, other than the above-mentioned workers, would be present at the port during offloading. Ports tend to be relatively large areas with little or no access by the general public. Impacts of the incident-free shipment of foreign research reactor spent nuclear fuel on the general public would not be expected until the shipment leaves the port area. It has also been assumed that all foreign research reactor spent nuclear fuel would be shipped in containers, regardless of whether transport occurs via container or general cargo vessels.

Once a shipment arrives in port, the spent nuclear fuel packages would be inspected by customs officials, U.S. Coast Guard personnel, port officials, etc. Up to six inspections performed by Federal, State, and local agencies, and the shipping agent are assumed to occur for each cask shipment. The durations of these inspections are provided in Table D-11. The assumption is made that the container is opened only for the inspection conducted when the cask is first off-loaded from the vessel.

In addition to the personnel involved in the inspections, there are other port workers (longshoremen, port officials, security personnel, etc.) who would be directly involved in or co-located near the off-loading of the container, its securing to the tractor-trailer, and in the movement of the container to a staging area. (The incident-free impact of offloading operations on the ship's crew were addressed in the marine impact analysis presented in Appendix C). While arrangements are expected to be made for the immediate departure of the spent nuclear fuel from the port of entry, it is recognized that situations could occur where there may be some delay in departing the port. For example, these delays could be caused by weather or road conditions. A delay of up to 24 hours is assumed for all shipments. To account for the impact of these delays, the dose to workers not directly involved in offloading activities was estimated. In addition to workers identified in Tables D-8 through D-9, it was assumed that 50 workers are exposed to the cask for 8 hours at a distance of 50 m (163 ft). This provides a dose estimate for the 24-hour storage period.

These dose estimates are independent of port location or type. Two types of cargo vessels have been addressed in the analysis, encompassing the range of times required for offloading activities. Container vessels required the least amount of time to offload; breakbulk vessels the longest. It has been assumed that offloading operations for both containerized breakbulk cargo and container cargo at all potential ports of entry is similar. These estimates are intended to bound the potential doses associated with port activities. As discussed above, breakbulk transport of the containerized fuel casks are expected to result in the largest dose to workers due to port operations due to the longer times associated with activities that bring workers into proximity of the casks.

External radiation for an intact shipping package must be below specified limits that control the exposure of the handling personnel and general public. These limits are set forth in 49 CFR 173.

The limit of interest established therein is a limit of 10 mrem per hour at any point 2 m (6.6 ft) from the vertical planes projected by the outer lateral surfaces of the transport vehicle. This limit is associated with an "exclusive-use" shipment, that is one in which no other cargo is loaded in the container used for the spent fuel transportation casks, not that the ship is an exclusive use vessel. All shipments within this program would be expected to fall within this category. In general, much of the foreign research reactor spent nuclear fuel potentially to be received would have cooled for a significant amount of time prior to shipment, resulting in external dose rates much less than the regulatory limit. Shipments of research reactor fuel in the past have had doses averaging approximately 2.3 mrem per hour at 1 m (3.3 ft) from the cask surface (see Section F.5 of Appendix F). Due to the scope of this program and the possibility that some of the fuel could be shipped fresher than has been done previously, the above cited regulatory limit has been used to estimate the worker exposures for all shipments. Appendix F, Section F.5, provides exposure rate versus distance for a transportation cask that is loaded with spent fuel that results in a dose rate at 2 m (6.6 ft) of 10 mrem per hour. This relationship was used to assign dose rates for the port activities.

Table D-12 and D-13 describe the types and numbers of personnel involved in the port activities associated with offloading the spent nuclear fuel. The times, distances, and maximum doses associated with these activities are listed for each type of personnel (all doses are simply the product of the dose rate to which the worker is exposed, based upon distance from the transportation cask, and the time the worker is exposed to this dose rate). The total port worker population and the maximally exposed individual doses are also provided. During incident-free port operations, the highest individual exposure would be to handlers and inspectors of the casks. Exposures are port-independent since it is assumed that operations would be similar at any of the potential or alternative ports of entry.

Table D-12 Port Worker Consequences from Shipment of Foreign Research Reactor Spent Nuclear Fuel on Breakbulk Vessels

<i>Exposed Workers</i>	<i>Exposure Distance (m)</i>	<i>Dose Rate (mrem/hr)</i>	<i>Exposure Time (minutes/cask)</i>	<i>Dose/Person/Cask (mrem)</i>	<i>Exposed Workers</i>	<i>Collective Dose (Person-rem)</i>	<i>Individual Risk (LCF)</i>	<i>Collective Risk (LCF)</i>
Longshoreman A1	0.50	37 ^b	0.25	0.15	2	0.00031	6.2E-08	1.2E-07
Longshoreman A2	0.50	37 ^b	3.3	2.0	2	0.0040	8.0E-07	1.6E-06
Longshoreman A3	6.00	6.4 ^b	0.25	0.027	1	0.000027	1.1E-08	1.1E-08
Longshoreman B1	0.50	34	1.0	0.57	4	0.0023	2.3E-07	9.1E-07
Maximum				2.0 ^a			8.0E-07 ^a	
Subtotal						0.0066		2.6E-06
Crane Operator 1	9.00	1.8	3.0	0.090	1	0.00009	3.6E-08	3.6E-08
Maximum				0.090 ^a			3.6E-08 ^a	
Subtotal						0.00009		3.6E-08
Truck Driver	3.00	7.1	3.0	0.36	1	0.00036	1.4E-07	1.4E-07
Maximum				0.36 ^a			1.4E-07 ^a	
Subtotal						0.00036		1.4E-07
Observers	6.00	3.2	0.25	0.013	4	0.000053	5.3E-09	2.1E-08
Observers	50	0.01	480	0.0802	50	0.0040	3.2E-08	1.6E-06
Maximum				0.080 ^a			3.2E-08 ^a	
Subtotal						0.0041		1.6E-06
USCG Inspector	1.5	15	2.0	0.5	1	0.00050	2.0E-07	2.0E-07
DOT Inspector	1.5	15	15	3.8	1	0.0038	1.5E-06	1.5E-06
NRC Inspector	1.5	15	10	2.5	1	0.0025	1.0E-06	1.0E-06
State Inspector	1.5	15	15	3.8	1	0.0038	1.5E-06	1.5E-06
Local/Port Inspector	1.5	15	5	1.3	1	0.0013	5.0E-07	5.0E-07
Receiver	1.5	15	5	1.3	1	0.0013	5.0E-07	5.0E-07
Maximum				3.8 ^a			1.5E-06 ^a	
Subtotal						0.013		5.2E-06
Maximum				3.8 ^a			1.5E-06 ^a	
Total						0.024		9.6E-06

^a Maximum individual exposure/risk.

^b Includes dose from second cask in hold.

USCG = U.S. Coast Guard, DOT = Department of Transportation

Table D-12 was developed using the information pertaining to the offloading of containerized foreign research reactor spent nuclear fuel from a breakbulk vessel. The exposure times and the distances from the transportation cask used to develop the dose estimates were derived from Table D-8 and assuming the longer transfer times associated with jib or boom cranes. The exposures (worker doses) resulting from the offloading activities associated with this type of vessel are the highest, on a per cask basis, of the three types of vessels considered for transport of the foreign research reactor spent nuclear fuel: breakbulk, container, and roll-on/roll-off (the chartered or purpose-built ship could conceivably be of any of these designs). Therefore, the dose estimates derived from this data provide the upper limit to the doses that could be calculated for the offloading activities.

Alternatively, the worker doses resulting from the offloading of a foreign research reactor spent nuclear fuel cask from a container vessel result in the lowest doses per cask of the types of vessels considered for use in the shipment of the foreign research reactor spent nuclear fuel. Table D-13 was developed using the exposure times and the distances from the transportation cask developed for a container vessel which are provided in Table D-8.

**Table D-13 Port Worker Consequences from Shipment of Foreign Research
Reactor Spent Nuclear Fuel on Containerized Vessels**

	<i>Exposure</i>	<i>Exposure</i>	<i>Dose/Person/</i>	<i>Collective</i>	<i>Individual</i>	<i>Collective</i>
				<i>Dose</i>	<i>Risk</i>	<i>Risk</i>

There is approximately a factor of two difference between the total worker dose resulting from the use of a breakbulk vessel and the use of a container vessel per transportation cask. There is a larger difference between the dose to the maximally exposed individual (MEI). The MEI for the breakbulk vessel receives a dose of 3.8 mrem per transportation cask offloading while for the offloading of a transportation cask from a container vessel the MEI receives a dose of 1.3 mrem.

Another consideration that could affect the total worker exposure is the possibility that the vessel transporting the foreign research reactor spent nuclear fuel could make intermediate port calls between the foreign port at which the transportation cask is loaded and the port of entry for the foreign research reactor spent nuclear fuel. At the intermediate ports of call, it is possible that cargo being shipped on the vessel and in the same hold as the transportation casks could be loaded/offloaded or moved. The analysis was expanded to consider the impacts on port workers at these intermediate ports. Table D-14 provides the information used to estimate the dose to the port workers in intermediate ports. The estimates consider that the hold in which the transportation casks are being stowed have been fully loaded and that all of the cargo in the vicinity of the transportation casks must be moved at one of the intermediate ports of call. The vessel assumed in the intermediate port analysis was a breakbulk vessel. As in the analysis of the impact of the offloading of the transportation casks, this assumption results in calculations based on the type of vessel that will result in the largest estimated impact on the port workers.

Table D-14 Port Worker Exposure - Each Intermediate Port

<i>Exposed Workers</i>	<i>Distance (m)</i>	<i>Dose Rate^a (mrem/hr)</i>	<i>Exposure Time (minutes)</i>	<i>Dose/Person (mrem)</i>	<i>Number of Workers^b</i>	<i>Collective Dose (person-rem)</i>	<i>Individual Risk (LCF)</i>	<i>Risk per Port Call (LCF)</i>
Longshoreman	1.5	18	5	1.5	4	--	--	--
	5	6.4	6	0.64	4	--	--	--
	8	4.6	1	0.08	4	--	--	--
Total				2.2	4	0.0089	0.00000089	0.0000035

^aThe dose rate includes the dose rate from two casks stored in the same hold.

^bThe same four workers are assumed to receive the entire dose from cargo handling activities in each intermediate port stop.

The per shipment data provided in Tables D-12 through D-14 was used to develop estimates of the incident-free impact of the marine shipment of 721 transportation casks on port workers. (The number of shipments required is derived in Appendix B. The 721 shipments used in this portion of the analysis exclude all shipments of Canadian origin which are expected to be overland shipments). Table D-15 provides the results of this analysis. Data is provided for two possible shipment conditions. In the first a breakbulk vessel is used to transport all of the foreign research reactor spent nuclear fuel and this vessel is assumed to make two intermediate port calls on every voyage. During these intermediate port calls the cargo in the same hold as the transportation casks is assumed to be moved (loaded and/or offloaded) twice. The impact on port workers, in terms of population exposure and risk, in the intermediate ports is therefore twice the impact presented in Table D-14. The second set of assumptions used is that all shipments are made on a container vessel that does not make intermediate port calls. These assumptions result in a lower estimate of port worker risk since the impact of intermediate port calls is eliminated and the offloading activities for a container vessel result in lower overall doses to the port workers. These two sets of assumptions, therefore, provide estimates of the range of potential impacts on port workers.

Table D-15 Integrated Port Worker Dose for the Basic Implementation of Management Alternative 1

	<i>Breakbulk Vessel with 2 Intermediate Port Calls</i>				<i>Container Vessel - No Intermediate Port Calls</i>			
	<i>Maximally Exposed Individual (rem)</i>	<i>Collective Dose to Workers (person-rem)</i>	<i>MEI Risk (LCF)</i>	<i>Worker Risk (LCF)</i>	<i>Maximally Exposed Individual (rem)</i>	<i>Collective Dose to Workers (person-rem)</i>	<i>MEI Risk (LCF)</i>	<i>Worker Risk (LCF)</i>
Inspectors	2.0 ^a	9.4	0.00080	0.0037	0.67	3.8	0.00027	0.0015
Port Handlers - Intermediate Ports	1.2	13	0.00047	0.0051	----	----	----	----
Port Handlers - Port of Entry	1.1	4.8	0.00043	0.009	0.25	1.1	0.00010	0.00044
Port Staging Personnel	0.19	3.2	0.000076	0.0013	0.21	3.3	0.00008	0.0013
Total	----	30.2	----	0.012	----	8.2	----	0.0033
Maximum	2.0^a	----	0.00080	----	0.67	----	0.00027	----

^aThis dose is above the allowed limit of 100 mrem/yr for the general population and would be mitigated to below the limit.

be expected to be shipped to a port on the East Coast of the United States if the shortest shipping distance were used. Western shipments are those that would be shipped to the West Coast port. From Table C-1, 535 shipments would be considered East Coast shipments; 186 West Coast. In determining the MEI, it was assumed that all of these East Coast shipments were made through the same port, and the same workers were involved in the offloading of the transportation casks for all shipments.

The total impact on the worker population was determined by using the full 721 transportation cask shipments. Both the MEI and the collective dose to the workers have been converted into a risk estimate of LCF resulting from the doses received in offloading the transportation casks loaded with foreign research reactor spent nuclear fuel. The range of impacts for the program is from 8.2 person-rem (0.0033 LCF) (for the use of container vessels with no intermediate port calls) to 30 person-rem (0.012 LCF) (for the use of breakbulk vessels with two intermediate port calls). These risks imply that there is between a three-in-a-thousand and a one-in-a-hundred chance that this program will result in one LCF as a result of the incident-free impact on port workers. The relationship between worker dose and cancer fatalities is that 1 rem is equivalent to 0.0004 LCF.

Under the basic implementation of Management Alternative 1, shipments would be received over a 13-year period, the 10-year period for spent nuclear fuel generation plus 3 additional years to allow for the coordination of available storage, transportation casks, shipping arrangements, etc. Assuming that the shipments were evenly distributed over the 13-year period, the doses to the MEI could be in excess of the DOE and NRC limits for doses to the general public (100 mrem per year). If breakbulk vessels were used, the MEI would receive approximately 150 mrem per year on average, if no mitigation steps were taken. If container vessels were used, no individuals are expected to receive a dose in excess of the public dose limits.

The above calculations were all performed assuming that every transportation cask was shipped with an external dose rate at the selected exclusive use regulatory limit of 10 mrem hour at 2 m (6.6 ft) from the surface of the container. This provides an estimate of the upper limit to what the incident-free impacts of the offloading of the transportation casks could be. To determine a more realistic estimate of these impacts, the analysis was redone using historical data on the external dose rates associated with the transportation of research reactor spent nuclear fuel. This analysis results in an average dose rate of

approximately 2.3 mrem per hour at 1 m (3.3 ft) from the cask surface, which is equivalent to a dose rate of 1 mrem per hour at 2 m (6.6 ft) from the cask surface. If the added distance from the cask surface to the container surface is not credited, this dose rate is one-tenth of the dose rate derived from the "exclusive use" regulatory limit. (See Appendix F, Section F.5)

Tables D-16 through D-19 provide the results of this analysis. No other assumptions were modified between this analysis from those used to develop the data presented earlier in this section. All of the results using the "historical" data are an order-of-magnitude lower than results derived from the use of the regulatory limit dose rates.

Table D-16 Port Worker Consequences from Shipment of Foreign Research Reactor Spent Nuclear Fuel on Breakbulk Vessels (Historical Data)

<i>Exposed Workers</i>	<i>Exposure Distance (m)</i>	<i>Dose Rate (mrem/hr)</i>	<i>Exposure Time (minutes/cask)</i>	<i>Dose/Person/Cask (mrem)</i>	<i>Exposed Workers</i>	<i>Collective Dose (Person-rem)</i>	<i>Individual Risk (LCF)</i>	<i>Collective Risk (LCF)</i>
Longshoreman A1	0.50	3.7 ^b	0.25	0.015	2	3.1E-05	6.2E-09	1.2E-08
Longshoreman A2	0.50	3.7 ^b	3.3	0.20	2	4.0E-04	8.0E-08	1.6E-07
Longshoreman A3	6.00	0.64 ^b	0.25	0.0027	1	2.7E-06	1.1E-09	1.1E-09
Longshoreman B1	0.50	34	1.0	0.057	4	2.3E-04	2.3E-08	9.1E-08
Maximum				0.20 ^a			8.0E-08a	
Subtotal						6.6E-04		2.6E-07
Crane Operator 1	9.00	0.18	3.0	0.009	1	9.0E-06	3.6E-09	3.6E-09
Maximum				0.009 ^a			3.6E-09 ^a	
Subtotal						9.0E-06		3.6E-09
Truck Driver	3.00	0.71	3.0	0.036	1	3.6E-05	1.4E-08	1.4E-08
Maximum				0.036 ^a			1.4E-08 ^a	
Subtotal						3.6E-05		1.4E-08
Observers	6.00	0.32	0.25	0.0013	4	5.3E-06	5.3E-10	2.1E-09
Observers	50	0.001	480	0.008	50	4.0E-04	3.2E-09	1.6E-07
Maximum				0.008 ^a			3.2E-09 ^a	
Subtotal						4.1E-04		1.6E-07
USCG Inspector	1.5	1.5	2.0	0.05	1	5.0E-05	2.0E-08	2.0E-08
DOT Inspector	1.5	1.5	15	0.38	1	3.8E-04	1.5E-07	1.5E-07
NRC Inspector	1.5	1.5	10	0.25	1	2.5E-04	1.0E-07	1.0E-07
State Inspector	1.5	1.5	15	0.38	1	3.8E-04	1.5E-07	1.5E-07
Local/Port Inspector	1.5	1.5	5	0.13	1	1.3E-04	5.0E-08	5.0E-08
Receiver	1.5	1.5	5	0.13	1	1.3E-04	5.0E-08	5.0E-08
Maximum				0.38			1.5E-07	
Subtotal						1.3E-03		5.2E-07
Maximum				0.38 ^a			1.5E-07 ^a	
Total						2.4E-03		9.6E-07

^aMaximum individual exposure/risk.

^bIncludes dose from second cask in hold.

USCG = U.S. Coast Guard, DOT = Department of Transportation

The total population dose (dose to the port workers) ranges from 3.0 person-rem (breakbulk vessel with two intermediate port calls) and 0.7 person-rem (container vessel with no intermediate port calls). This corresponds to a risk of 0.0012 to 0.00033 LCF, that is, a one-in-a-thousand to a one-in-three thousand chance of incurring one LCF. For a population of workers, the relationship between exposure and LCF is

**Table D-17 Port Worker Consequences from Shipment of Foreign Research
Reactor Spent Nuclear Fuel on Containerized Vessels (Historical Data)**

	<i>Exposure Distance</i>	<i>Dose Rate</i>	<i>Exposure Time</i>	<i>Dose/Person/ Cask</i>	<i>Exposed</i>	<i>Collective Dose</i>	<i>Individual Risk (ICR)</i>	<i>Collective Risk (ICR)</i>
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Table D-19 Integrated Port Worker Dose for the Basic Implementation of Management Alternative 1 (Historical Cask Dose Rates)

	<i>Breakbulk Vessel with 2 Intermediate Port Calls</i>				<i>Container Vessel - No Intermediate Port Calls</i>			
	<i>Maximally Exposed Individual (rem)</i>	<i>Collective Dose (person-rem)</i>	<i>MEI Risk (LCF)</i>	<i>Risk (LCF)</i>	<i>Maximally Exposed Individual (rem)</i>	<i>Collective Dose (person-rem)</i>	<i>MEI Risk (LCF)</i>	<i>Risk (LCF)</i>
Inspectors	0.20	0.94	0.00008	0.00037	0.07	0.38	0.00002	0.00015
Port Handlers - Intermediate Ports	0.12	1.3	0.000047	0.00051	----	----	----	----
Port Handlers - Port of Entry	0.11	0.5	0.000043	0.00019	0.03	0.11	0.000010	0.000044
Port Staging Personnel	0.02	0.3	0.000008	0.00013	0.02	0.33	0.000009	0.00013
Maximum	0.20 ^a		0.00008 ^a		0.07 ^a		0.000027 ^a	
Total		3.0		0.0012		0.8		0.00033

^aMaximally exposed individual.

1 rem is equivalent to 0.0004 LCF. The MEI would receive a dose of 0.2 rem over the 13-year period of the basic implementation of Management Alternative 1. This is approximately 15 mrem per year, which is well below the NRC and DOE limits for exposure to the public (100 mrem per year).

The results of these analyses indicate that some of the port personnel that handle and inspect foreign research reactor spent nuclear fuel shipping containers could receive doses that exceed public exposure limits established by DOE and the NRC, especially when the dose rate from the casks are assumed to be at the regulatory limit for exclusive use shipments of 10 mrem per hour measured 2 m (6.6 ft) from the surface of the shipping container. The analyses results are conservative due to three factors. First, it is estimated that for most shipments the external dose rate for the loaded transportation cask would be near the historic dose rates, which average a factor of ten below the regulatory limit. Second, the analyses assumed that the same port inspectors and handlers handle all shipments. In reality, most port personnel work on shifts, so the likelihood of all shipments being handled by the same shift is low. Finally, all of the shipments passing through any East Coast port were assumed to pass through the same port. In reality, it is more than likely that the shipments would be made through more than a single port.

However, the existence of some shipments with external dose rates closer to the exclusive use regulatory limit suggests that DOE should provide a means to assure that individual port personnel do not receive doses in excess of the public dose limits. As a minimum, the program should establish administrative procedures that would maintain records of the exposure rates associated with each shipment and the ports of departure and entry. The measurement of interest for the record keeping would be the external dose rates outside the container, which houses the transportation cask.

radioactive material shipments has been estimated. The cumulative analysis is necessary to determine the impact on port workers from doses received through actions associated with the foreign research reactor spent fuel return program and through other actions, both DOE and commercially initiated.

The maximum exposure for a worker involved in transporting the foreign research reactor fuel is predicted to result from activities associated with the unloading of the spent fuel casks in port, cask inspection, and cask preparation for truck shipment to the management sites. If the same individuals were present for all proposed shipments of foreign research spent nuclear fuel on an annual basis (a conservative assumption), the maximum dose would be approximately 150 mrem, as discussed in the previous section. This estimate is based on the use of the "exclusive use" regulatory external dose rate. Based on historical spent nuclear fuel shipment data, this maximum annual dose would be 15 mrem.

Since commercial ports routinely receive other shipments of radioactive materials under other DOE programs or other commercial activities, the port worker would also be potentially exposed to additional sources of radiation. To estimate the annual exposure rate of port workers resulting from handling of commercial radioactive material shipments, the following must be determined.

- Number of radioactive packages handled per year
- Length of exposure time per package
- Dose rate per package

Records of shipments through the potential ports of entry were used to estimate the annual throughput of packages with radioactive contents. Radioactive materials were identified by the product code listed for

shipments were then grouped into six categories and exposure rates at 1 m

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The annual dose to port workers resulting from handling commercial radioactive shipments were estimated based on the number of shipments passing through the port and an estimated handling time of ten minutes per skid or cylinder. Each port typically uses three shifts per day and therefore workers were assumed to be exposed to one-third of the packages passing through the port. This is a conservative assumption given that there are typically many hours of downtime per day.

D.4.7 Incident-Free Port Impacts of Alternatives to the Basic Implementation of Management Alternative 1

Three alternatives to the basic implementation of Management Alternative 1 were identified that could impact the incident-free port risk calculations that were performed. (Chapter 2 describes the alternatives to the basic implementation of Management Alternative 1.) The implementation subalternative of *accepting spent nuclear fuel only from developing countries*, which are identified as countries other than high-income economies, would result in a reduction in the amount of spent nuclear fuel transported by ship. Table C-12 listed the countries that are considered to be countries other than high-income economies and the number of foreign research reactor spent nuclear fuel shipments that would be required to transport their spent nuclear fuel to the United States. One hundred sixty-eight transportation casks would be shipped to the United States under this implementation subalternative. Under the *foreign research reactor spent nuclear fuel for 5-years only* implementation subalternative, the number of shipments of foreign research reactor spent nuclear fuel would be reduced to 586 shipments requiring ocean transport. (The derivation of the number of shipments required in this alternative is presented in Appendix B.)

The third alternative, with the capability to impact the results of the incident-free port risk analysis, is the *overseas processing of the foreign research reactor spent nuclear fuel with the shipment of the vitrified waste to a storage facility in the United States*. Under this alternative, eight transportation cask shipments of vitrified waste could be made.

In addition to these alternatives, a hybrid alternative was analyzed. In this alternative, those countries that